

UW-Madison GIS Professional Programs - **Map Chat** Guest Talk

A Cartographic Journey

Atlas (Chenxiao) Guo

Ph.D. Candidate in Geography (Cartography/GIS)

Spatial Computing and Data Mining Lab + UW Cartography Lab

University of Wisconsin-Madison

Dec 4, 2024



SPATIAL COMPUTING AND DATA MINING LAB
University of Wisconsin-Madison



CARTOGRAPHY LAB
University of Wisconsin-Madison

I, ATLAS (Background)



- "Atlas" Chenxiao Guo, from Zibo, China
- Education
 - B.S. in GIS (RS & GIS Engineering)
 - M.S. in Geography (GIS)
 - Ph.D. (Candidate) in Geography (Cart/GIS)
- Affiliation
 - Spatial Computing and Data Mining (SCDM) Lab
 - University of Wisconsin Cartography Lab (CartLab)
 - Former Intern at Institute for Local Self-Reliance, United Nations Development Programme

Sun Yat-sen University

University of Georgia

University of Wisconsin-Madison

(advised by Prof. Qunying Huang)

(advised by Prof. Robert Roth)

United Nations Development Programme

My Cartographic Turn (From GIS to Cartography)

- Research Outline

- Keywords: spatiotemporal analysis, cartographic visualization, location-based social media, geospatial data mining and “GeoAI”, natural disaster management (focusing on hurricanes)
- “GeoAI-Powered Cartography for Natural Disaster Management”

- Motivation

- Lifelong love to maps (as you all have!)
- TA experience of UW-Madison’s cartographic curriculum (e.g. Geog 370, 572, 575, 970)
- NACIS Conference experiences (every year since 2020)
- Madison & Wisconsin Covid-19 Pandemic Dashboard + 2 Internships

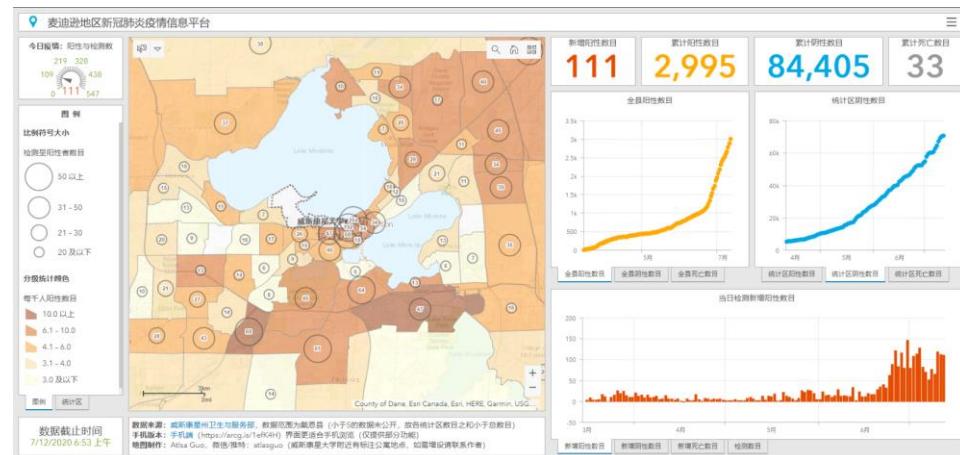


Madison & WI Covid Dashboard

- Project Overview
 - 3-year-long voluntary non-academic project
Originally serving Chinese students' parents in China
 - Static + web dashboard (desktop + mobile)
 - Chinese + English
 - Focusing on Madison area, later extended to statewide coverage
 - Key Attributes: case number, case density; cumulative, weekly, historical; overall, demographic groups



Initial Static Maps (Chinese)



Initial Dashboard (Chinese)



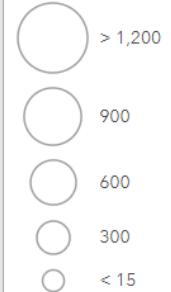
Proportional Circle

Cum. Positivity Rate (%)



Legend

POSITIVE



Tract Color (Choropleth)

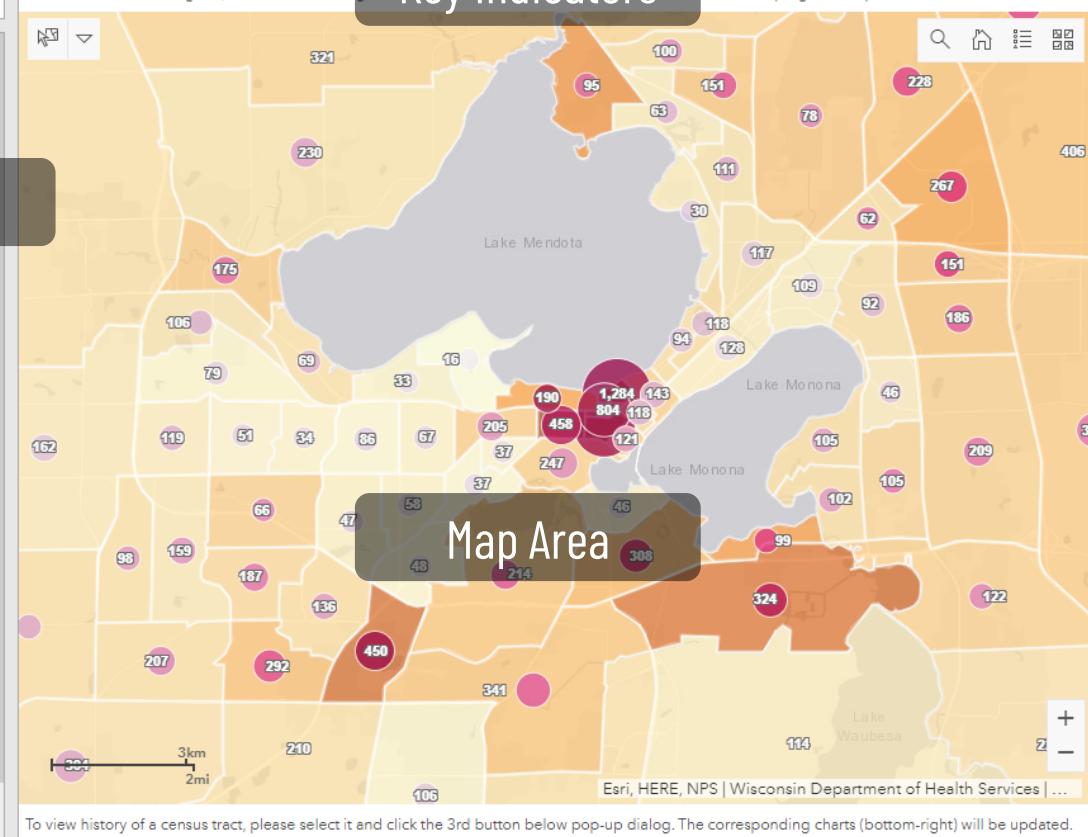


Legend for Dane County Map
only. For other maps, please click
their top-right legend icon.

 Legend (Total) 
New Positive
634New Tests
1,546Total Positive
20,590Ever Hospitalized
649Total Deaths
57

Key Indicators

To switch or view the legend, either click the "Legend" button in the bottom right corner of each chart, or the 3rd icon on top-right of map.



Tech Support: This dashboard is designed by Chenxiao (Atles) Guo, Ph.D. student member at Spatial Computing and Data Mining Lab, UW-Madison Department of Geography. Email: atles.guo@wisc.edu. Twitter: [@cartoguophy](#).

Disclaimer: Please follow the official guidance from Wisconsin Department of Health Services, Public Health Madison & Dane County, and UW-Madison Smart Restart to help slow the spread of covid-19 in our communities together.

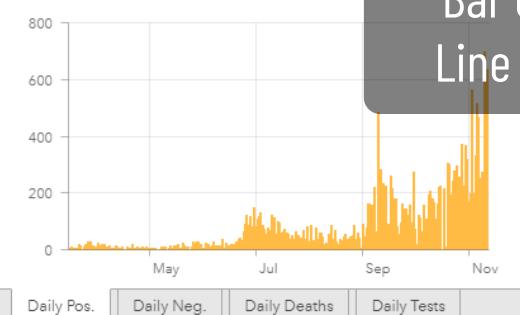
Today's Positive
(in all tested)

Total count is under-estimated, as negative results are self-reported.

Total Positive
(in all population)

Positive cases include multiple tests by same person.

Daily Positive Cases



Cumulative Positive Cases



Positive Cases by Hospitalization



Hospitalization Today's Rate Cum. Rate

Death by Sex

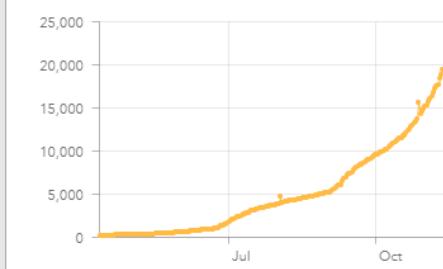


Pie Charts Bar Charts Line Charts

Group with less than 5 people are not displayed.

by Sex by Age by Race by Ethnicity

Cumulative Positive Cases (by Census Tract)

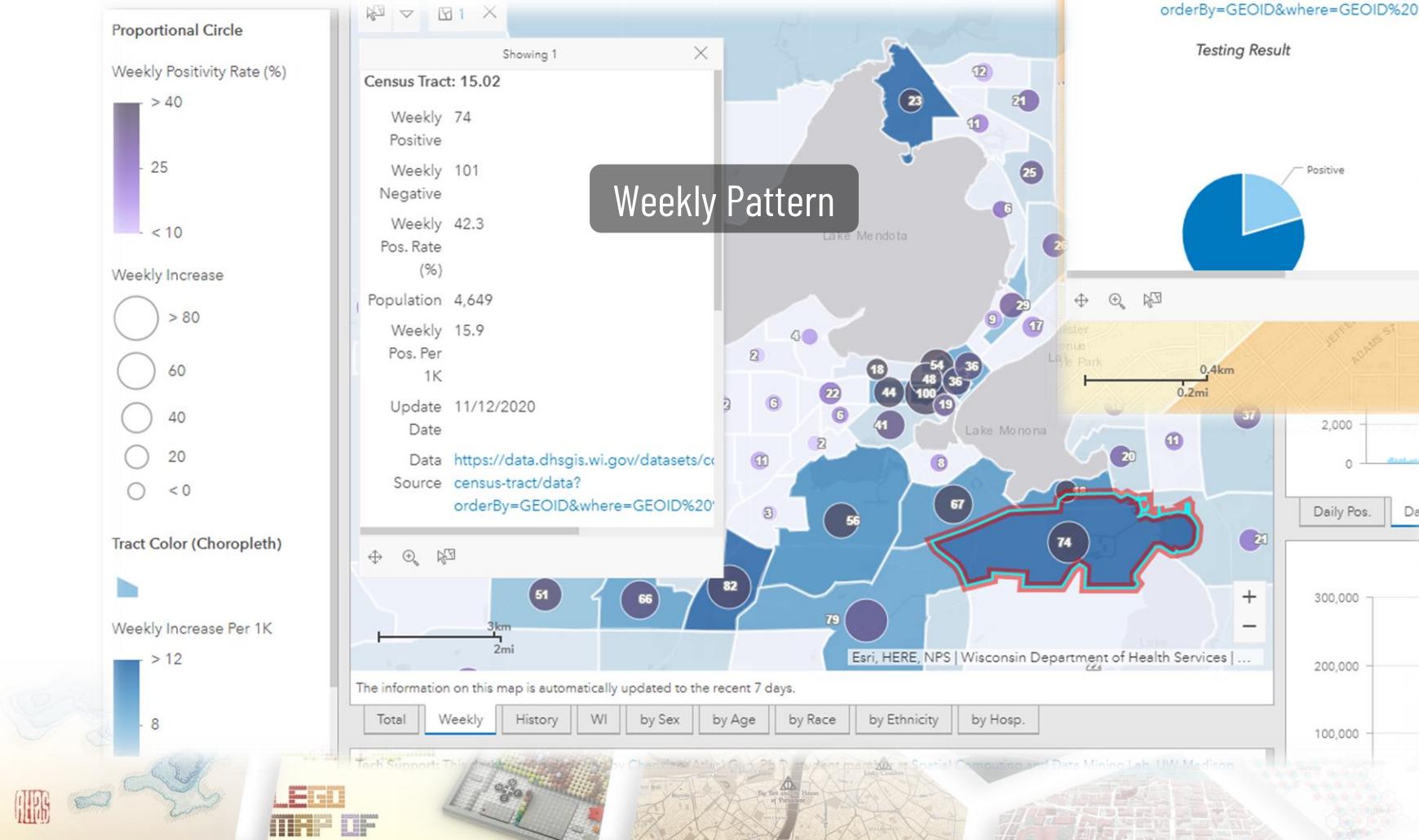


Please select census tract in map, click the 3rd button at the bottom of pop-up dialog. If nothing is selected, this chart shows the sum of all census tracts with at least 5 cases.

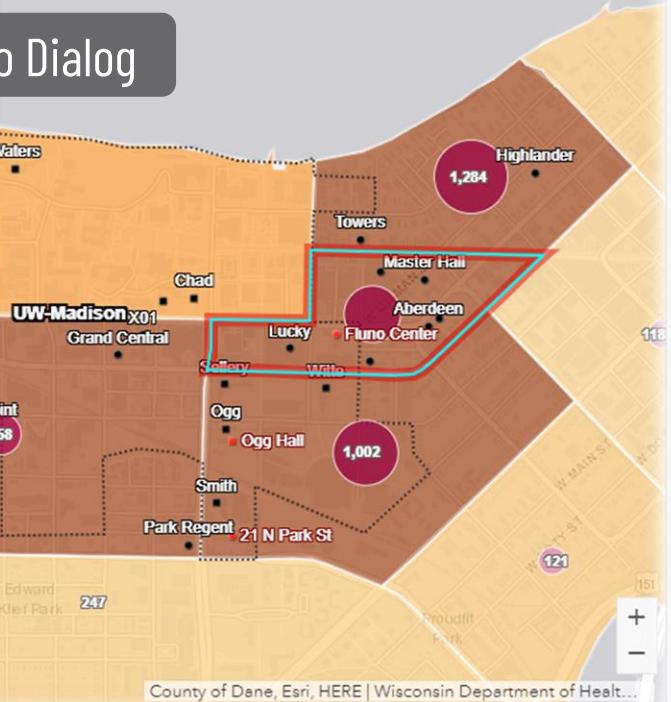
Positive (by Tract) Hospitalized (by Tract)

Data Update at 11/12/2020, 3:00 PM

More features were added...



Detail Info Dialog



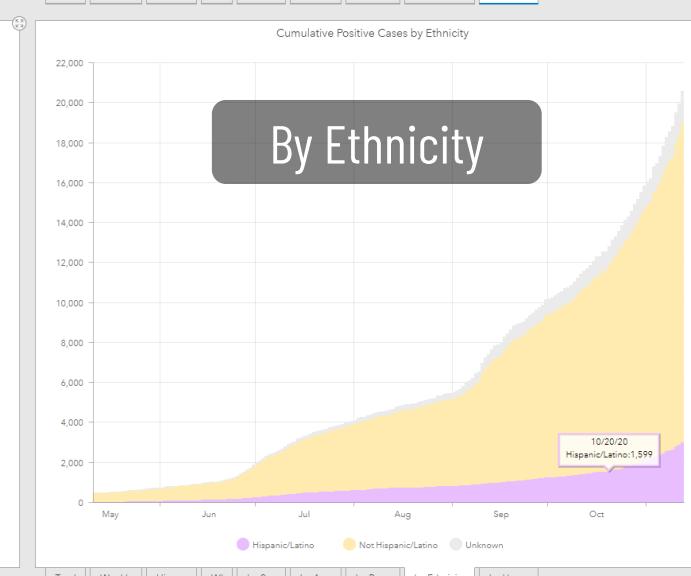
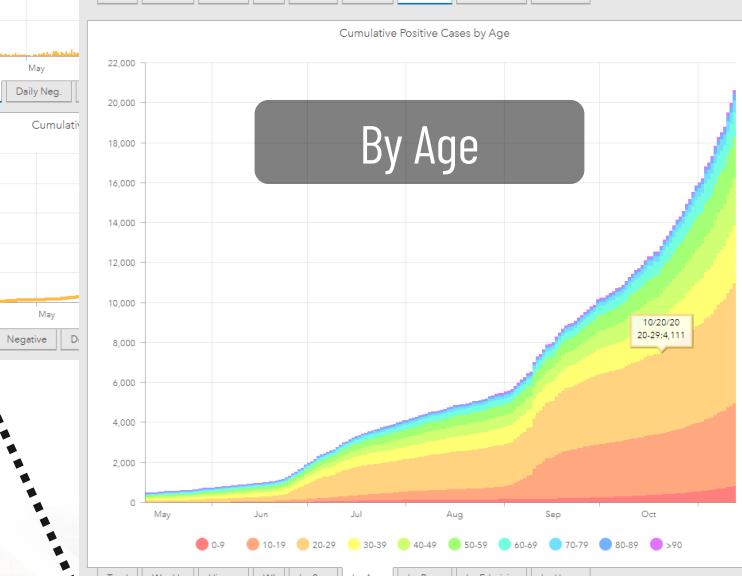
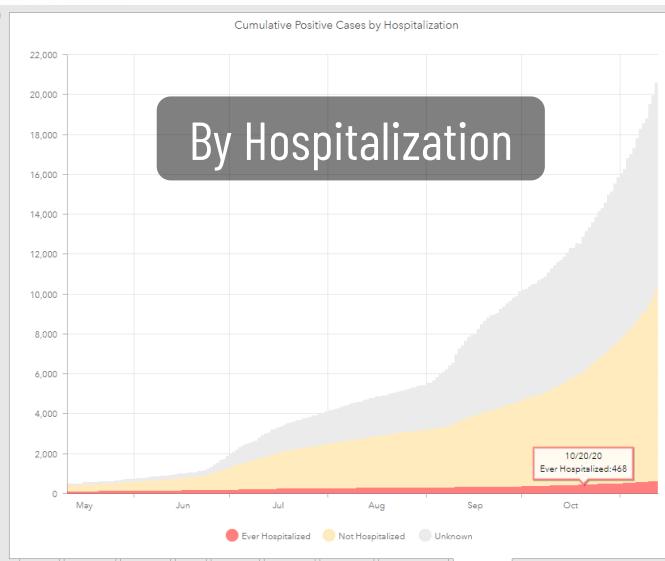
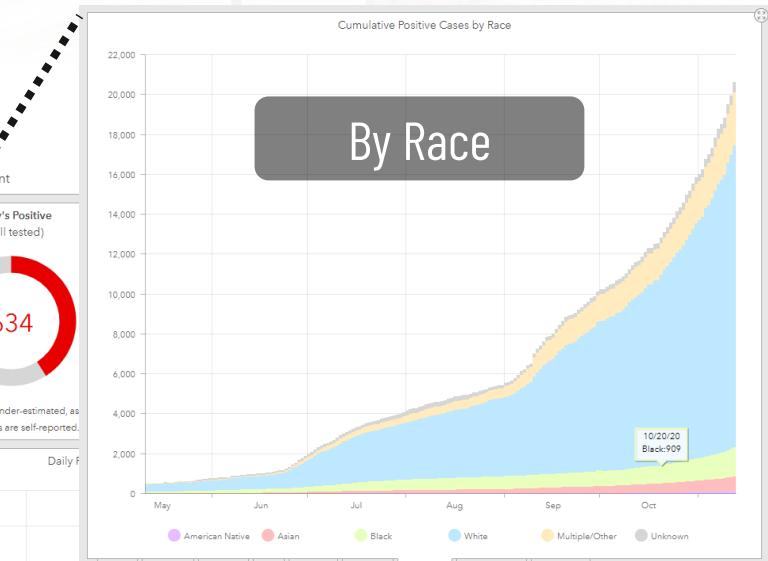
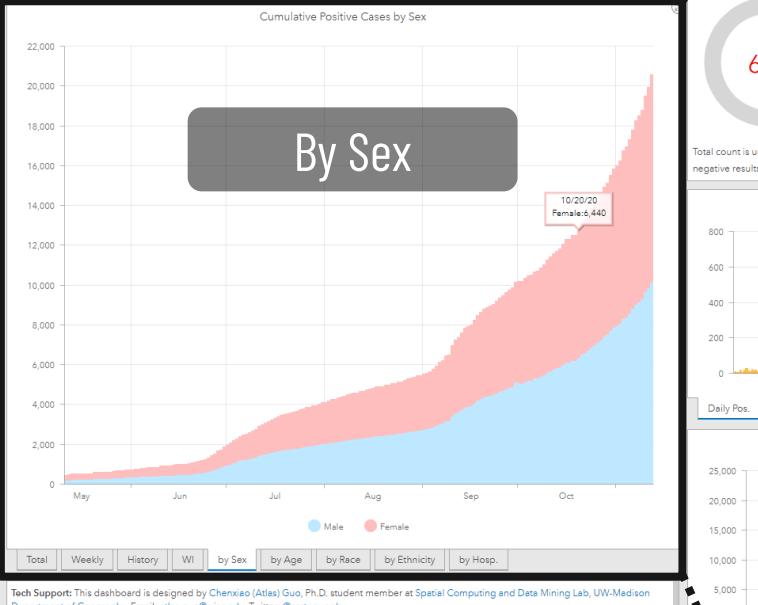
Temporal
Filter

Charts of Cumulative Cases

Madison Area COVID-19 Pandemic Dashboard by Spatial Computing and Data Mining Lab, UW-Madison Geography Department

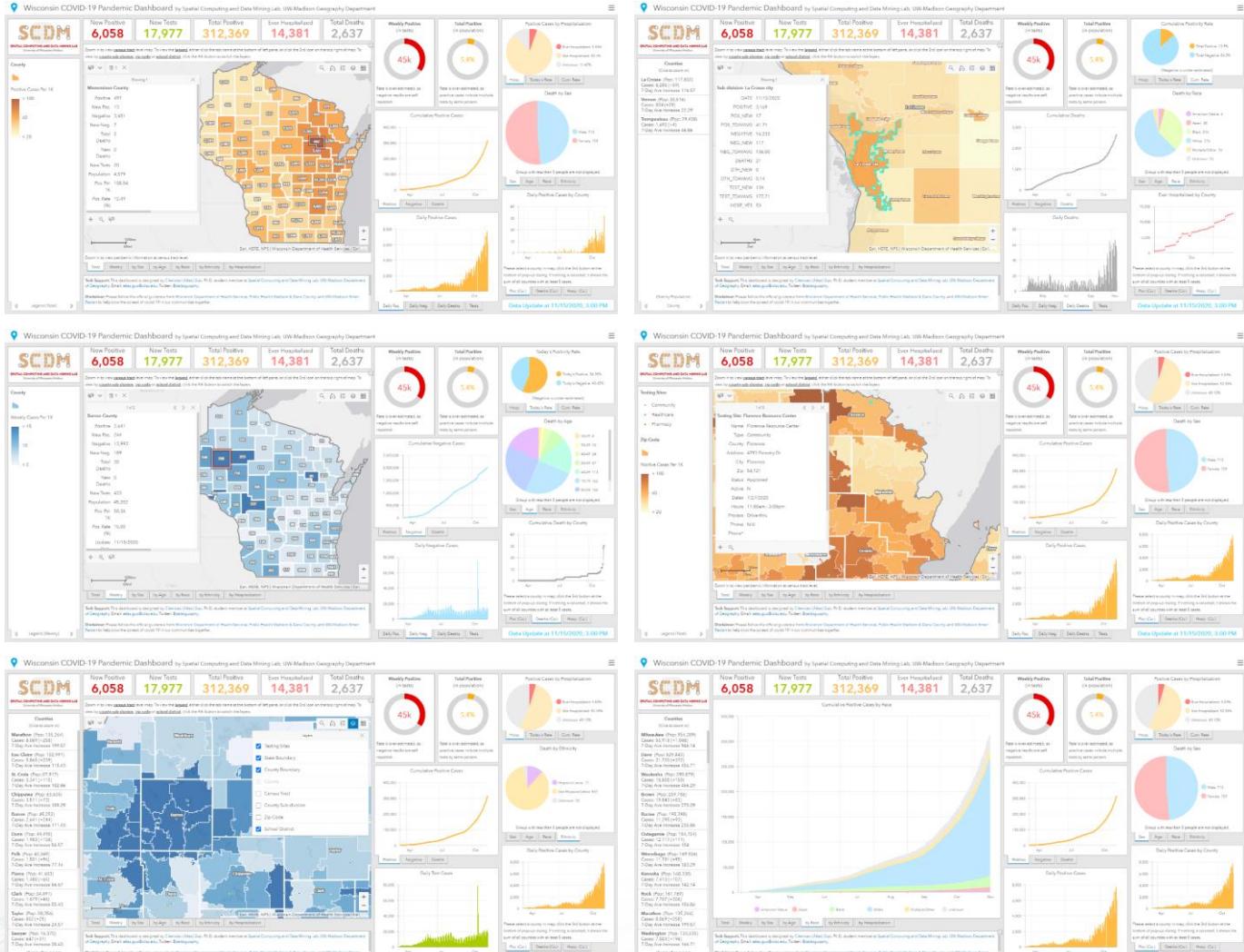


New Positive **634**
New Tests **1,546**
Total Positive **20,590**
Ever Hospitalized **649**
Total Deaths **57**



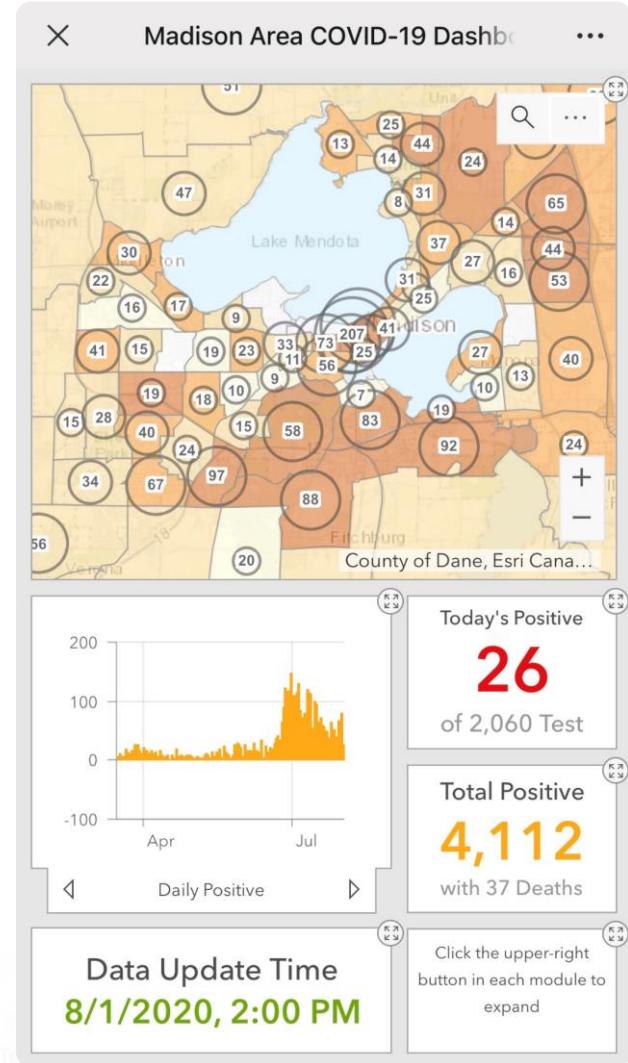
Statewide Dashboard In Same Style

At County and Sub-division (city, village, town) Levels



Mobile Version

Key features and indicators only



Serving Broader Community

MADNEWS (WeChat public account run by UW students; Madison's largest Chinese media):
Daily (2020-2022) & weekly (2023) static maps and weekly summary (2020-2023)



Channel 3000: 2 articles with interview videos



Badger Herald: 1 article

The Badger HERALD

News Features Sports Opinion ArtsEtc Visuals Banter

City of Madison

PHMDC moves to crisis model of contact tracing, illustrates need to prevent COVID-19 spread

Third peak started late October with daily increases of 250 cases on average, UW Ph.D. student says

By HALEY BILLS Nov 9, 2020 Twitter Share

ISOLATION HOUSING AREA CLOSED

University of Wisconsin Geography Ph.D. student Chenxiao (Atlas) Guo spoke on the spike in cases.

"The third [COVID-19] peak started in late October and is still going on and arguably getting worse, with daily increases of about 250 on average," Guo said. "Quite different from the previous patterns, this time we can barely figure out the outbreak 'hot-spot' spatially."

Guo created an interactive dashboard of Dane County and Wisconsin that shows the density of COVID-19 cases spatially, as well as other relevant information such as total hospitalizations, new tests and deaths. The dashboard uses data from the Wisconsin Department of Health Services.

Dane County, UW divided over COVID-19 in Madison
With COVID-19 cases skyrocketing across Wisconsin, Dane County and the University of Wisconsin leadership remain divided on how to best... Read...

Temporally, there were two previous COVID-19 peaks in Dane County — one in late June when there were about 100 new cases per day, and the second in early to mid-September when there were about 200 new cases per day, according to Guo. The outbreak center for the first peak was located in downtown Madison around State Street while the outbreak center for the second peak was located around the east side of campus and the State and Johnson region, Guo said.

The pandemic is rapidly spreading out to not only suburban areas, but also to pretty rural areas in all directions of Dane County, in which the north, east and northeast of Dane County are the worst currently," Guo said. "Summarizing the pattern using text might evoke unnecessary panic, and that's why the map itself matters."

Guo said he hopes to see the dashboard playing a positive role in limiting the spread of COVID-19 by alerting people of high-risk areas to avoid or to take more protective actions within. For instance, the recent increase of cases in rural areas shows the broader importance of social distancing even in non-crowded areas, according to Guo.

Confirming My Cartographic Vision

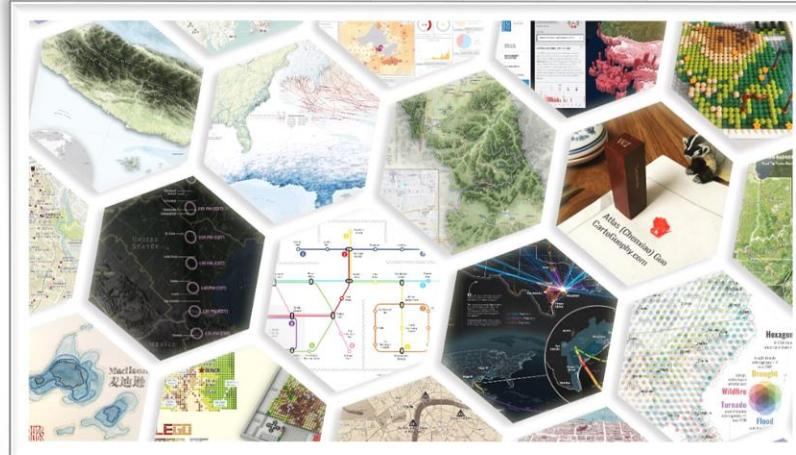
- Rich Harvest
 - Witness the power of map in benefiting communities
 - Joy & experience during the map design/development process (800+ images, 80K views)
 - Awards: Honorable Mention of Digital Map Award in CaGIS Map Design Competition (2021), Best Student Map in Wisconsin Land Information Association (WLIA) Map Contest (2021)
- Read More on **CartoGuophy.com** (applies to the rest)
 - Madison Area and Wisconsin Covid Pandemic Dashboards
 - Static Map Series for Covid-19 Pandemics in Madison Area:
- Focused more on static map designs, and gradually developed own mapping style



Let the Cartographic Journey Begin!

Showcasing award-winning maps in 4 themes:

- Theme 1 - **Hurricane Trajectory Visualization** (Research)
- Theme 2 - **Multivariate Thematic Mapping** (Context)
- Theme 3 - **Reference Map Hillshading** (Passion)
- Theme 4 - **LEGO Style Map Design** (Creativity)





This mosaic graphic compiles my major map products by May 2024

Zibo Map of Culture and Tourism

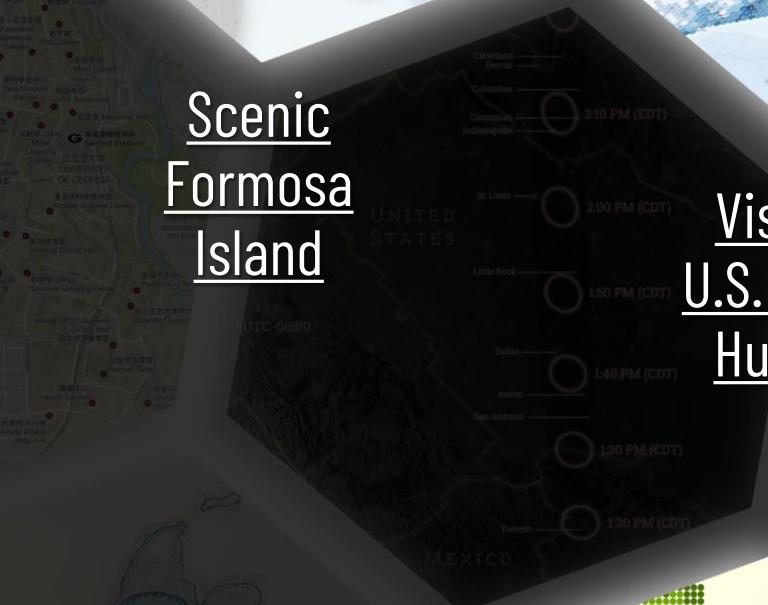


LEGO Map of Wisconsin



United States of Natural Disasters

Scenic Formosa Island



Visualizing U.S. Historical Hurricanes

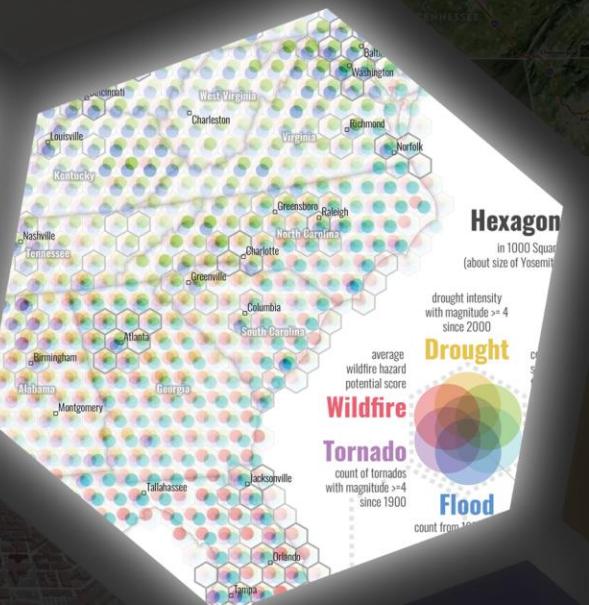
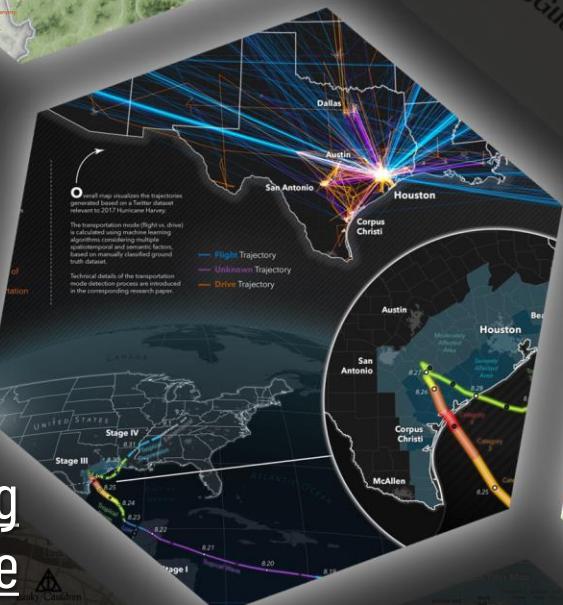


LEGO Map of Colorado



LEGO MAP OF

Revealing Hurricane Harvey



Hexagon

in 1000 Square
(about size of Yosemite)

drought intensity
with magnitude >= 4
since 2000

average
wildfire hazard
potential score

Wildfire

tornado
count of tornadoes
with magnitude >= 4
since 1900

Flood

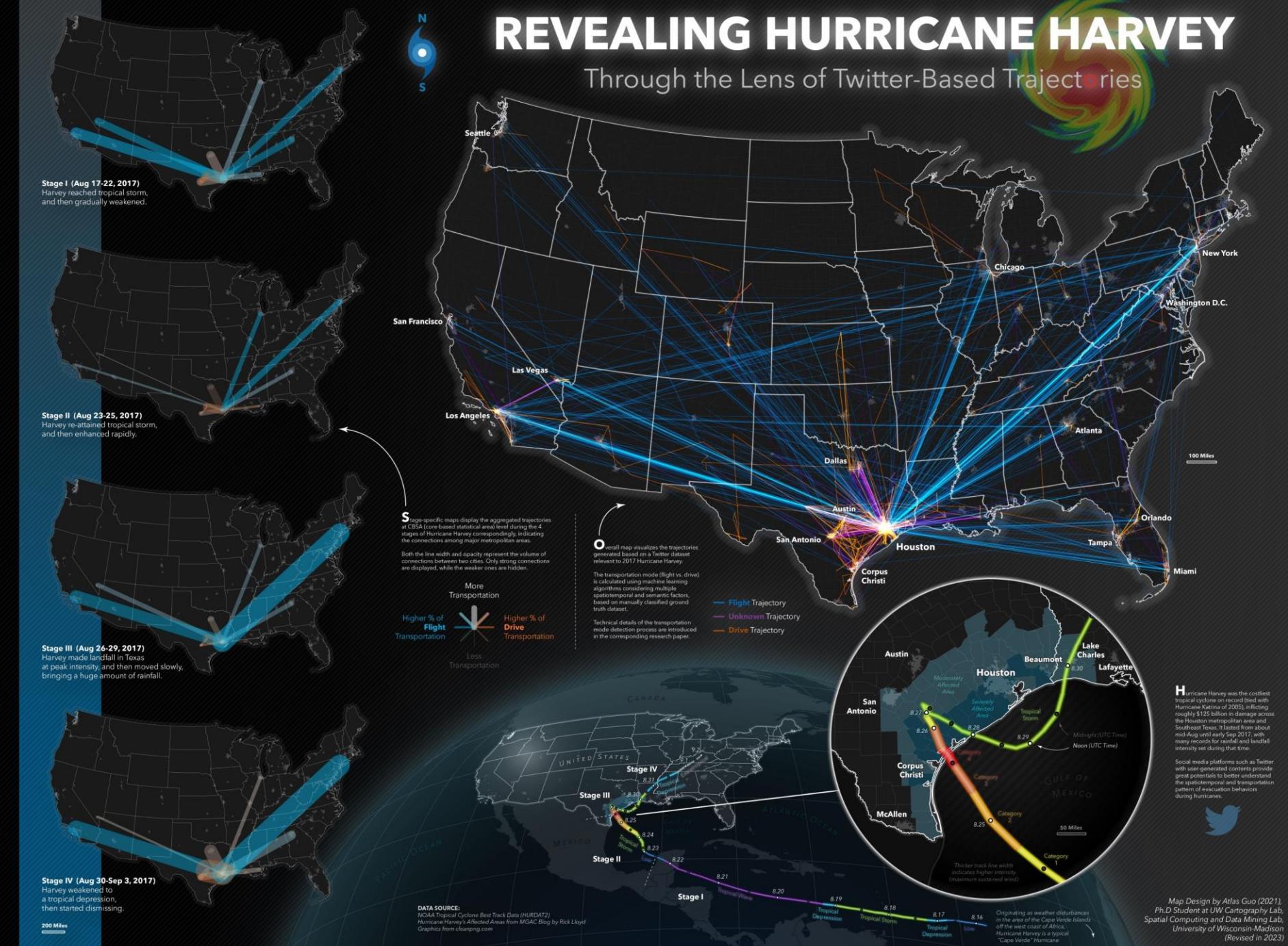
Visualizing U.S. Historical Hurricanes

Theme 1 - Hurricane Trajectory Visualization

Revealing
Hurricane
Harvey

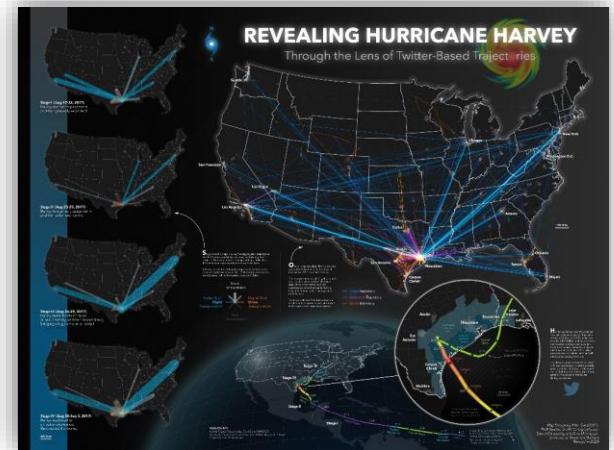
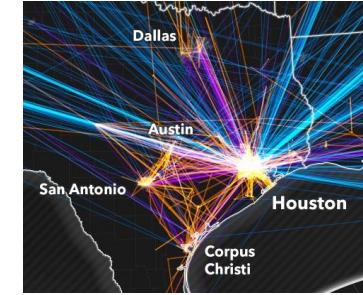
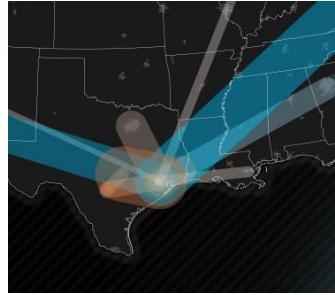
REVEALING HURRICANE HARVEY

Through the Lens of Twitter-Based Trajectories

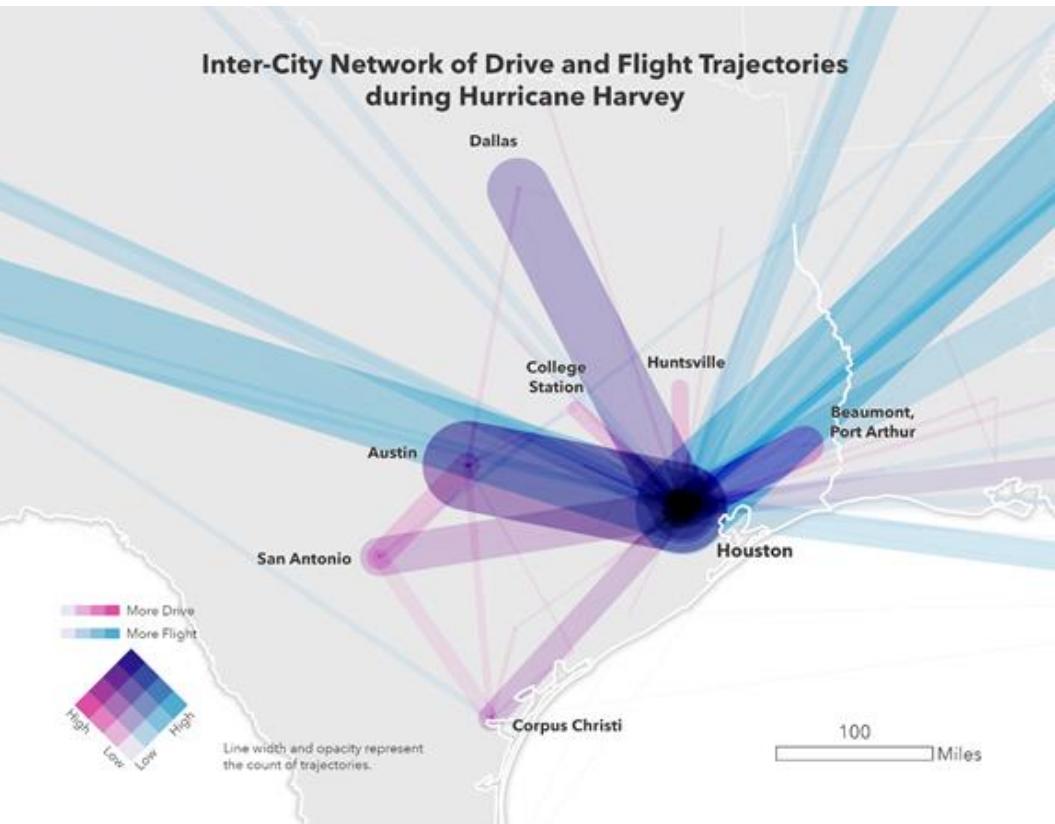
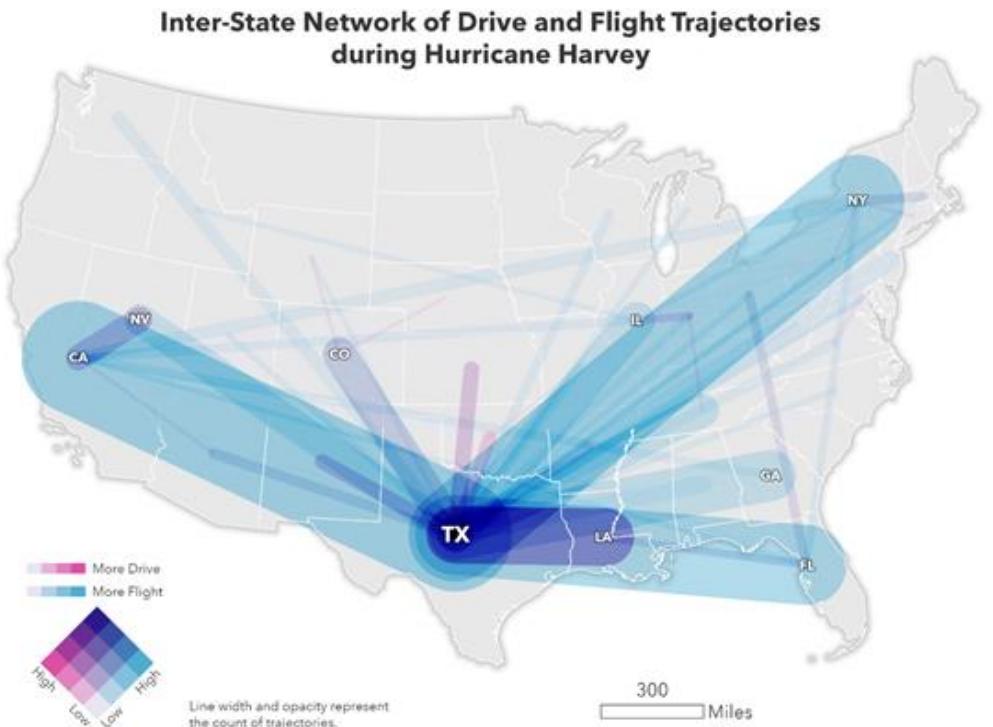


Revealing Hurricane Harvey

- Visualization for research paper
 - Tweet-based trajectories of same twitter user (individual segments + aggregated network)
 - Machine learning algorithms to detect transportation mode (**flight/drive**) based on spatiotemporal characteristics and Tweet textual information
 - Under the circumstance of Hurricane Harvey in 2017

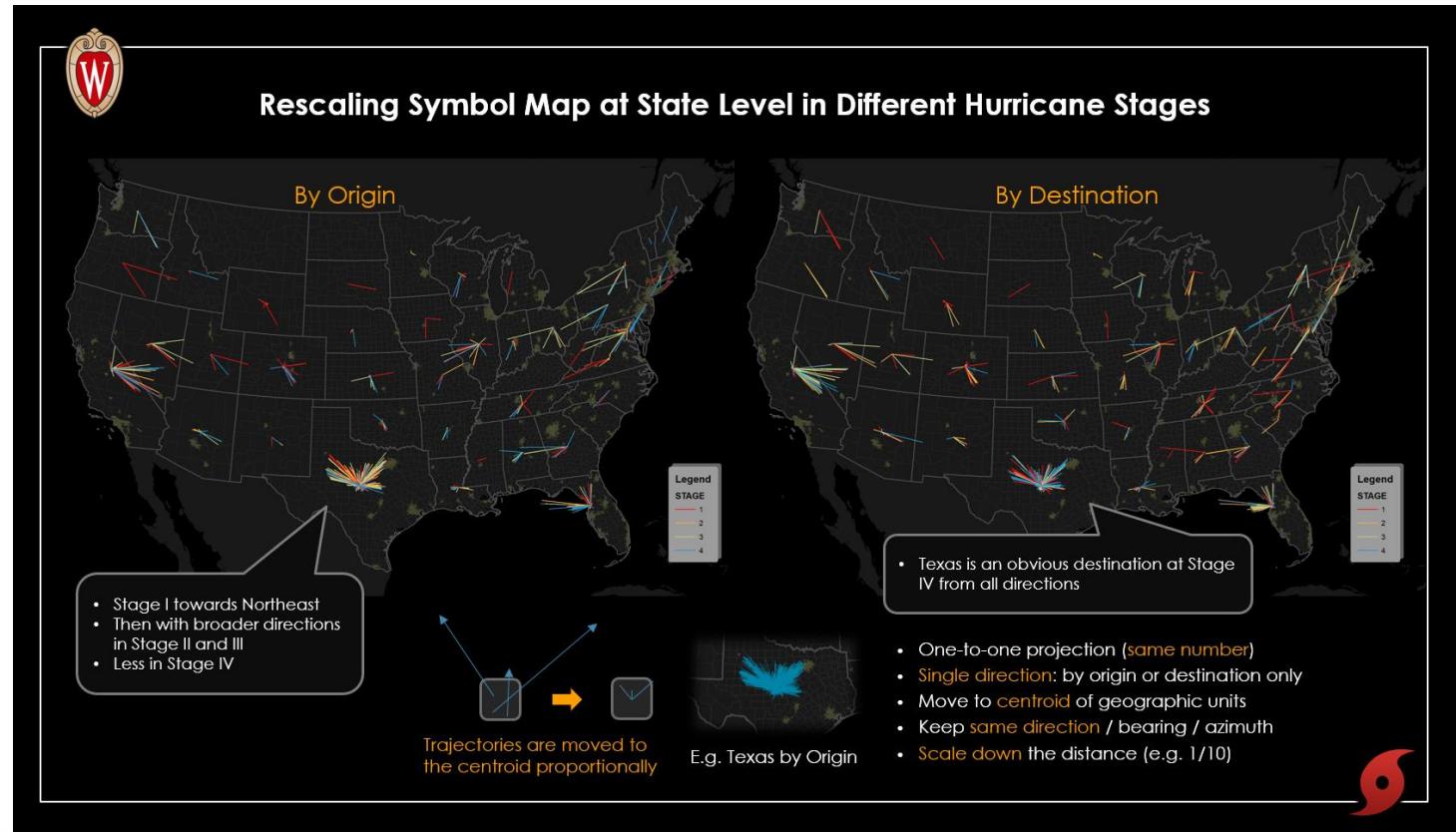


Aggregating Trajectories to Network



Rescaled Symbol Design for Trajectories

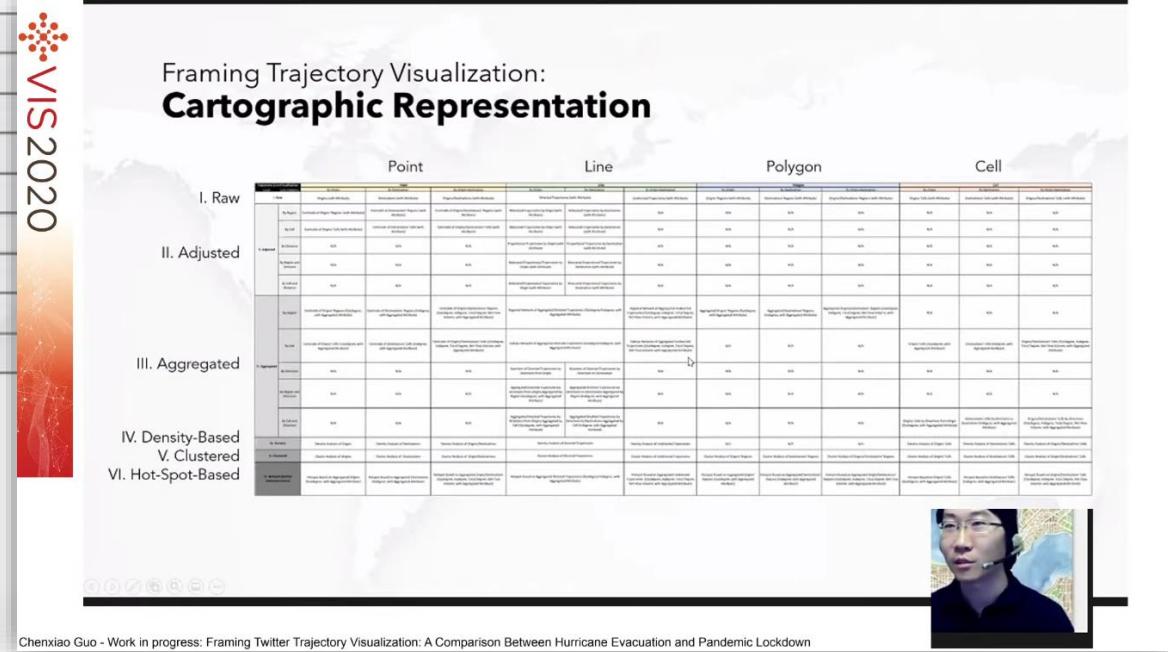
- A previous exploration of visualizing individual trajectories
- Scaled proportionally; relocated by origins or by destinations



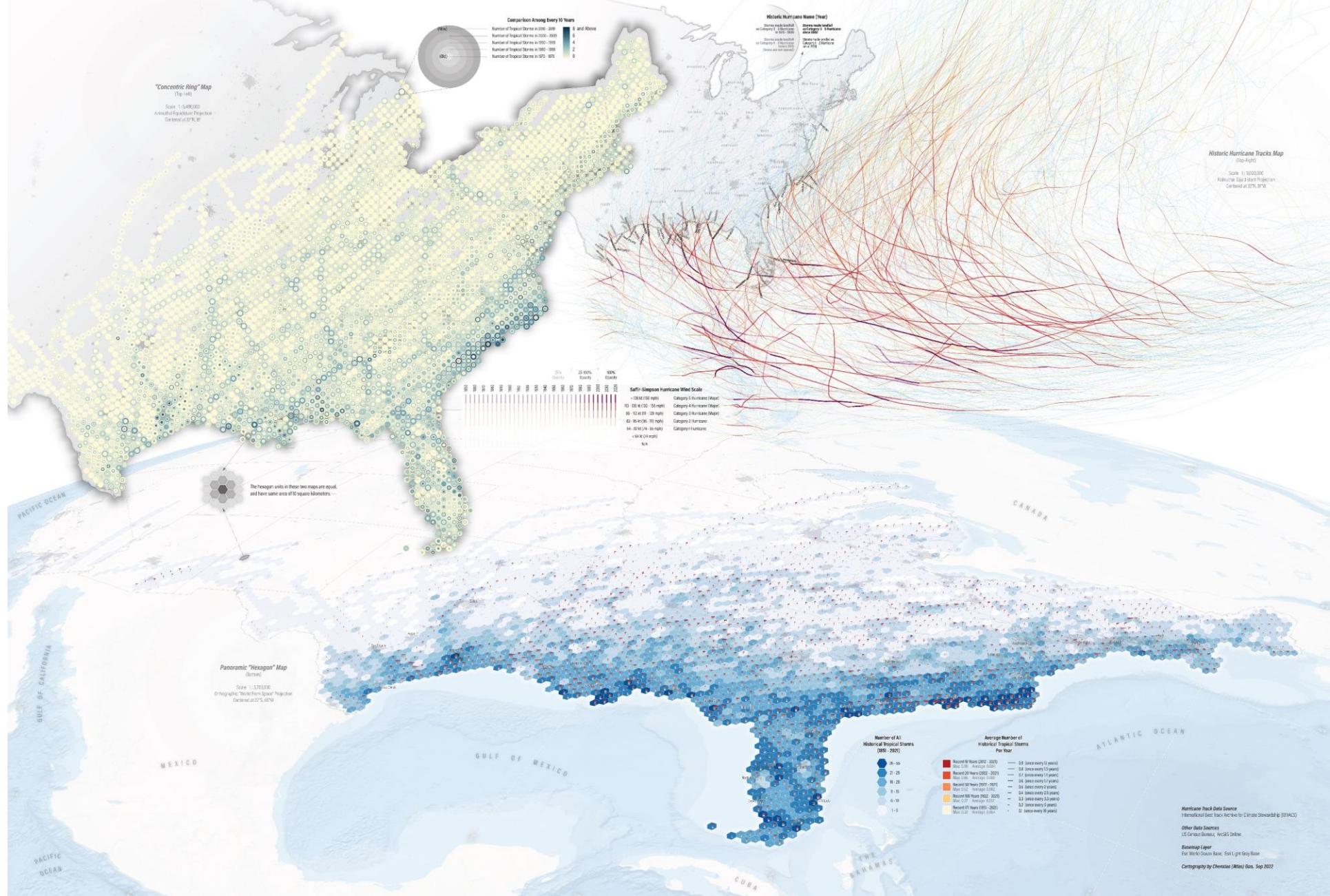
Framing (Twitter) Trajectory Visualization

Trajectory Geo-Visualization		Point			Line			Polygon			Cell		
Level	Sub-Category	Origen	Destination	O-D Pair	Origen	Destination	O-D Pair	Origen	Destination	O-D Pair	Origen	Destination	O-D Pair
I. Raw													
II. Adjusted	By Region												
	By Cell												
	By Distance												
	By Region and Distance												
	By Cell and Distance												
III. Aggregated	By Region												
	By Cell												
	By Direction												
	By Region and Direction												
	By Cell and Direction												
IV. Density													
V. Clustered													
VI. Hotspot (Spatial Autocorrelation)													

- Conceptualizing all possible cases for trajectory visualizations

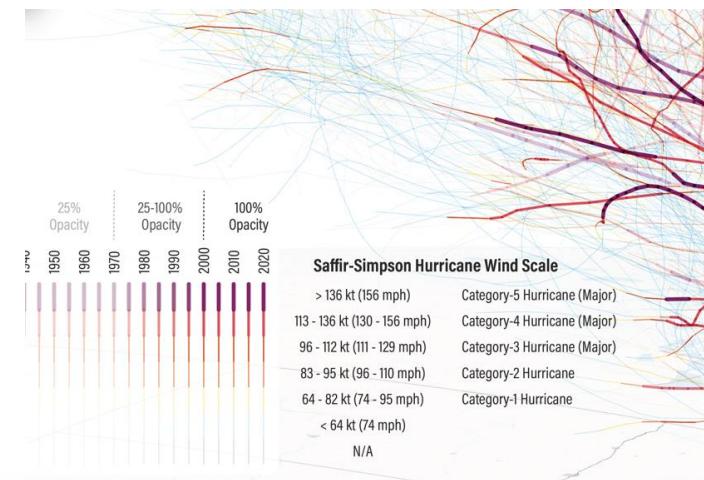
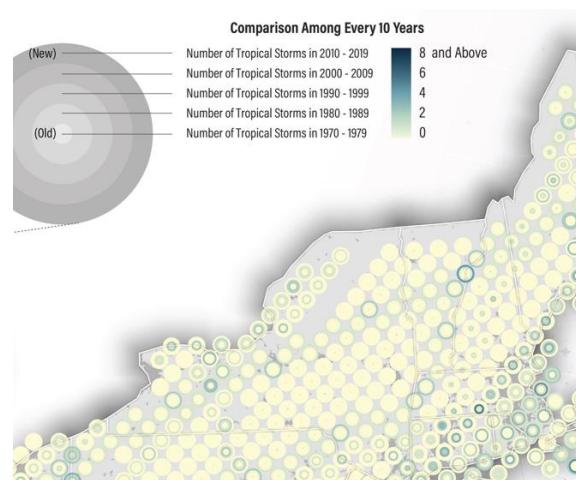
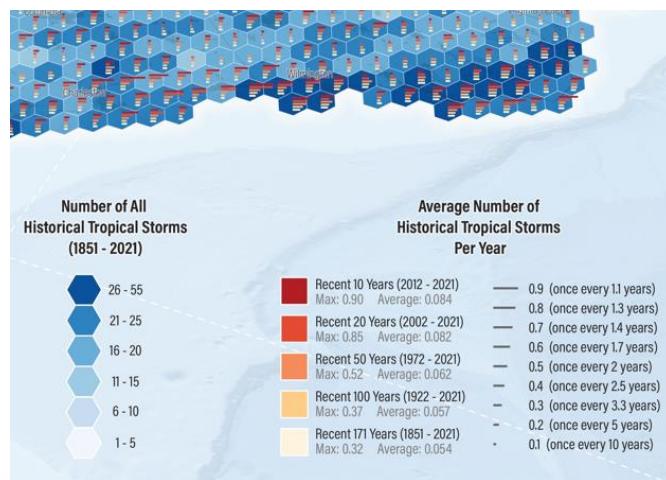
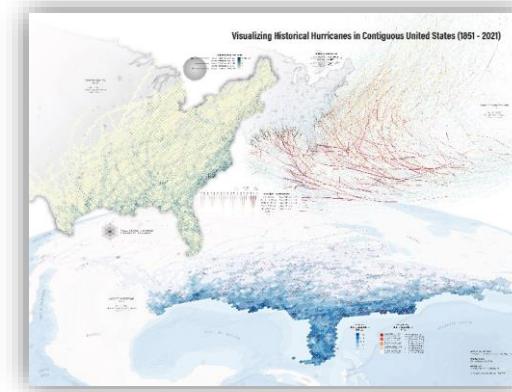


Visualizing Historical Hurricanes in Contiguous United States (1851 - 2021)



Visualizing U.S. Historical Hurricanes (1851-2021)

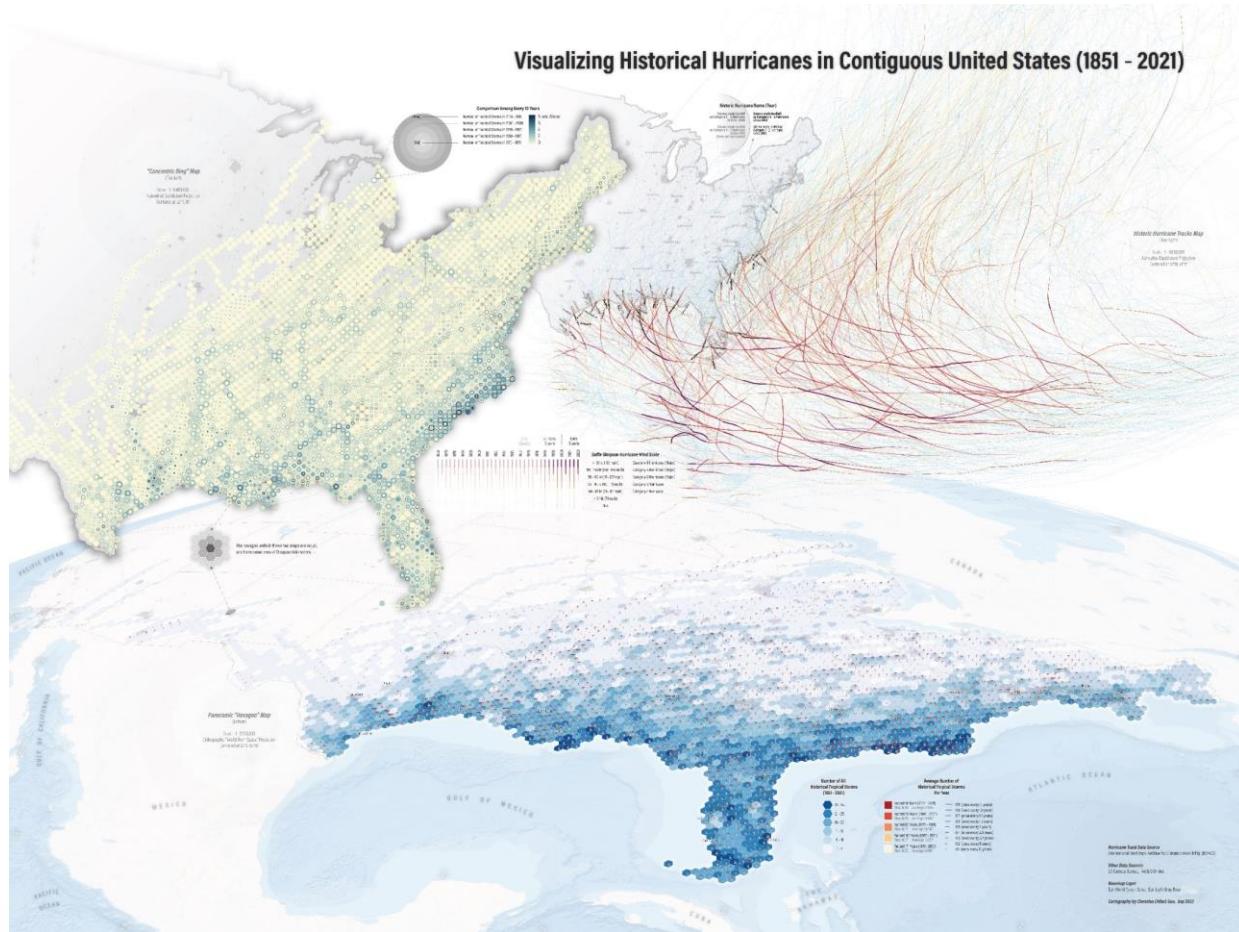
- Combining 3 visualizations into a single map poster
 - The Panoramic “Hexagon” Map (bottom)
 - The “Concentric Ring” Map (top-left)
 - The “Historic Hurricane Tracks” Map (top-right)

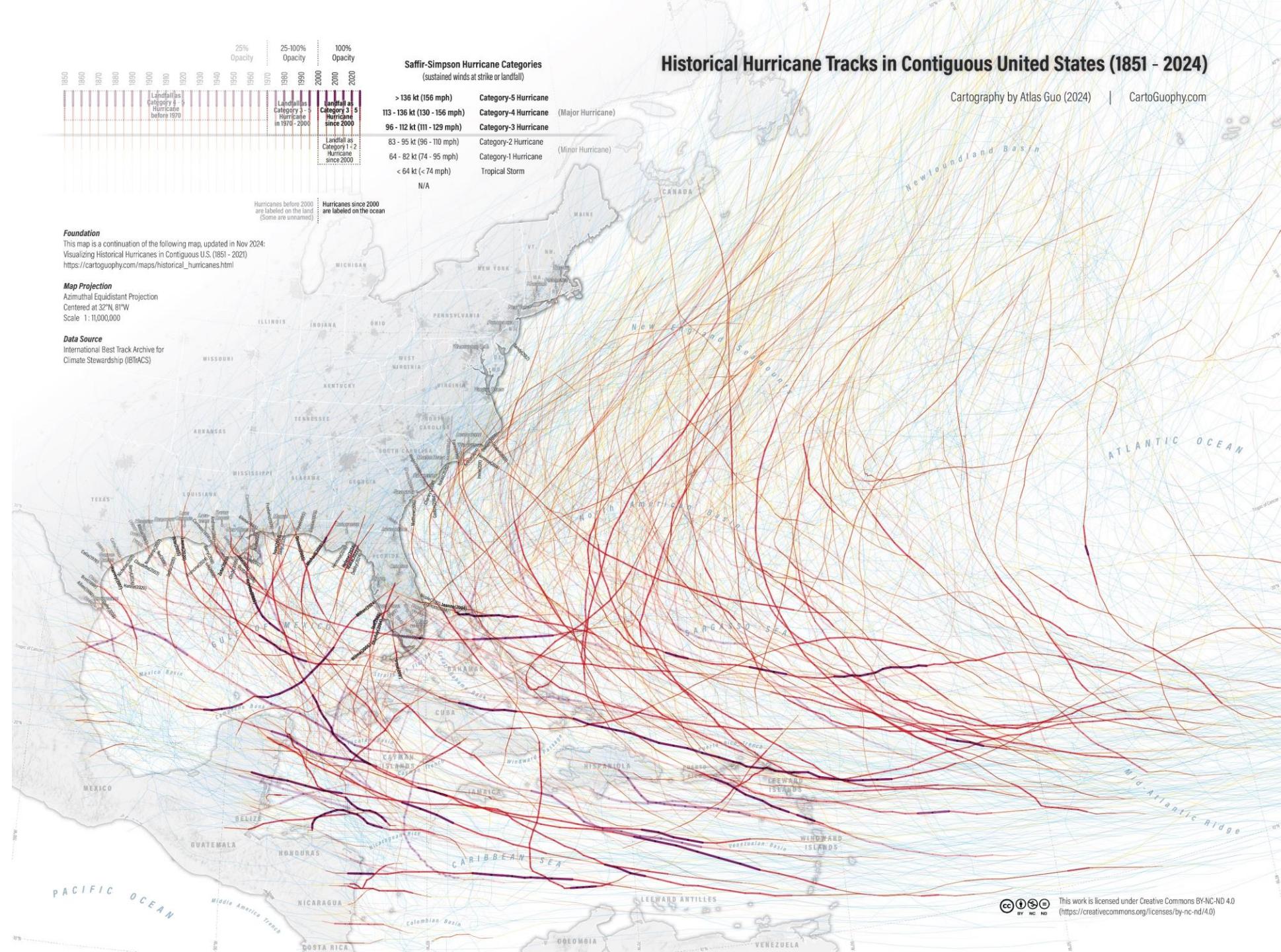


Map 1 & 2 share the same 10-sq-km hexagon unit.

Visualizing U.S. Historical Hurricanes (1851-2021)

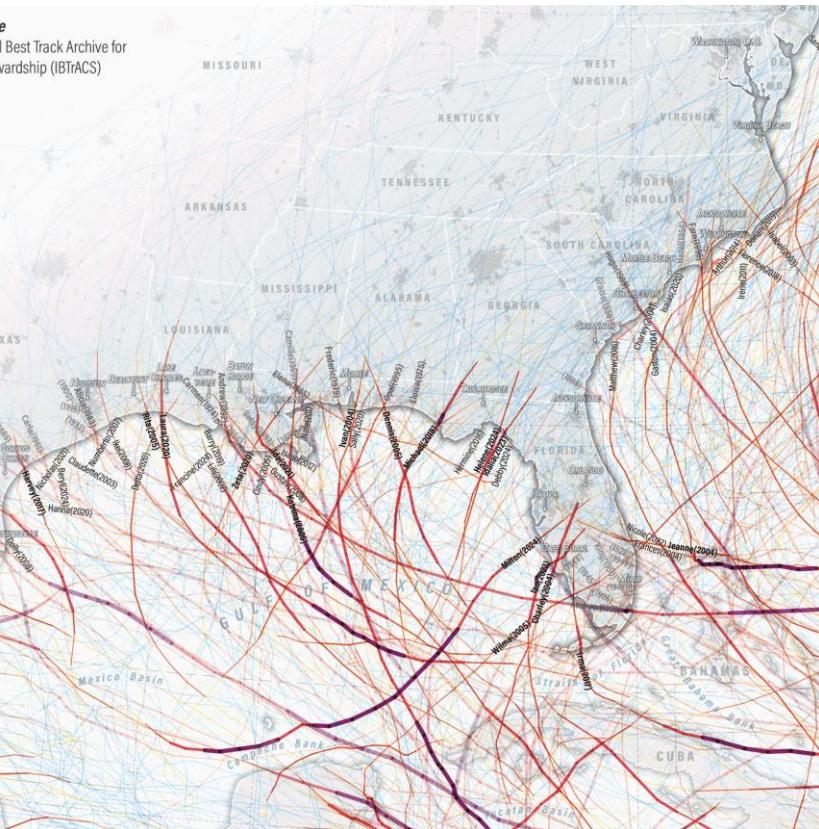
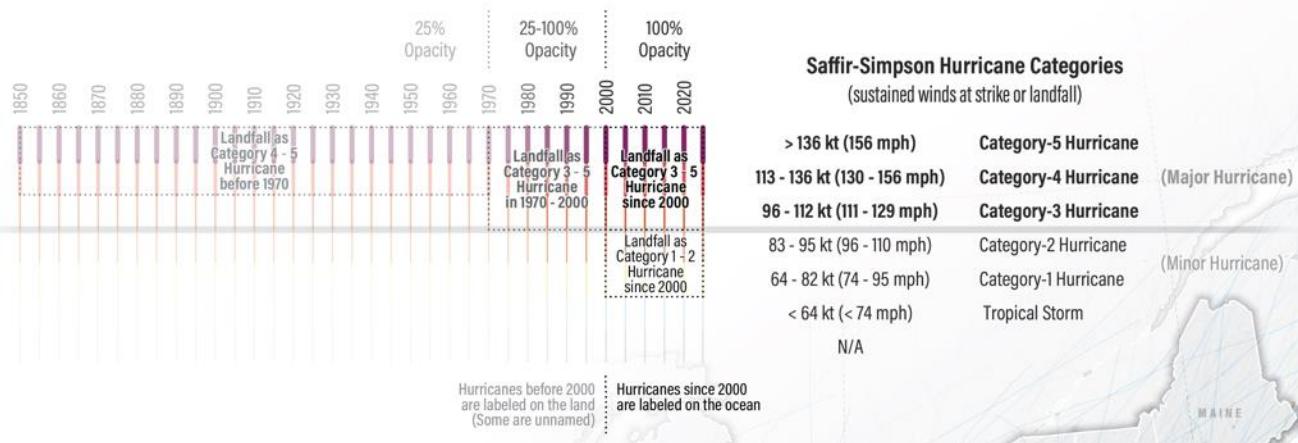
- Considerations in design
 - Map Projection (& Layout)
 - Thematic symbols & legend design
 - Temporal information
 - Visual hierarchy
 - Typography





Visualizing Historical Hurricane Tracks (1851-2024)

- Easy to be updated yearly
- GIF Animation shows the new tracks in 2024, including 5 hurricanes making landfall

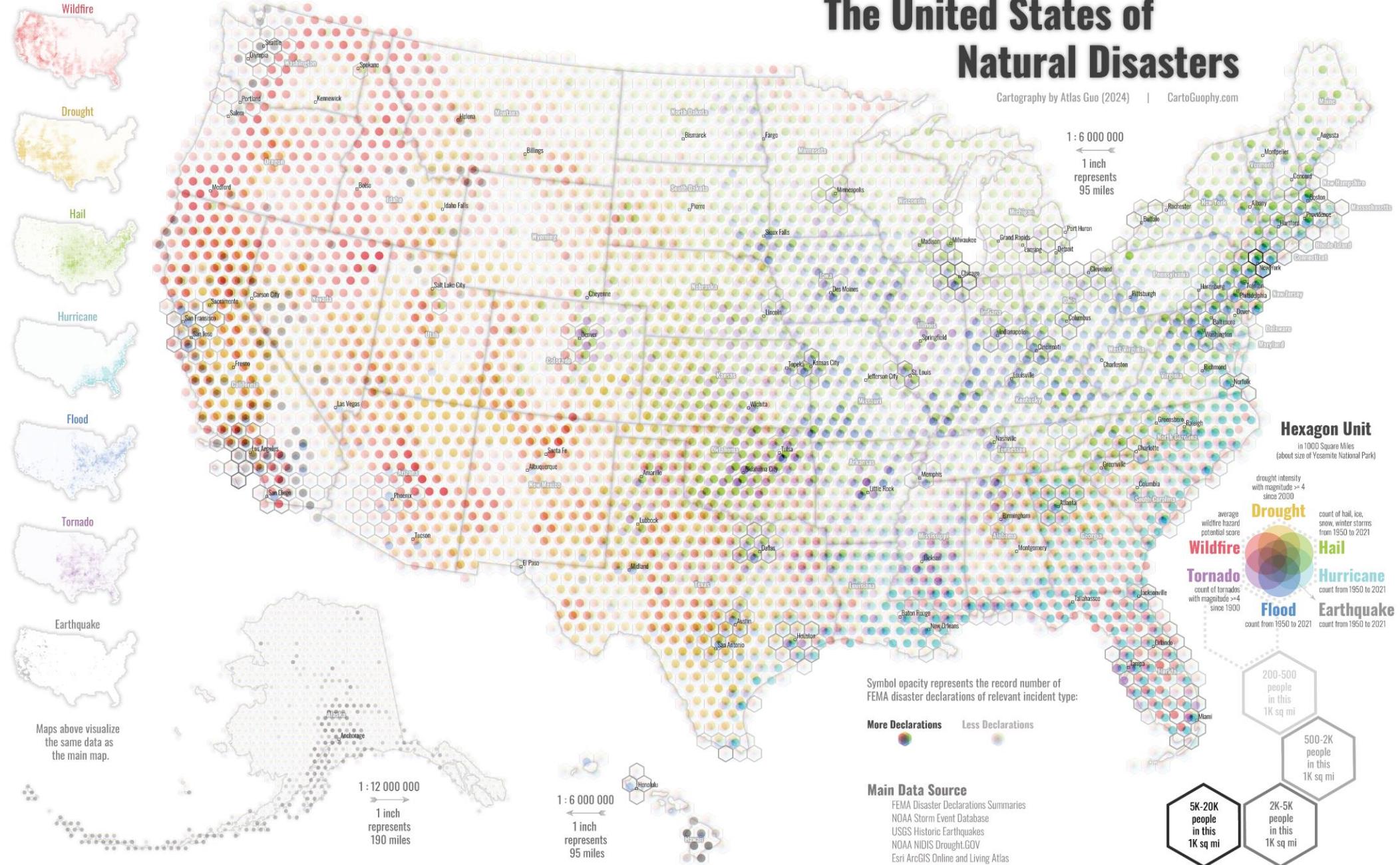


Theme 2 - Multivariate Thematic Mapping

United States of
Natural Disasters

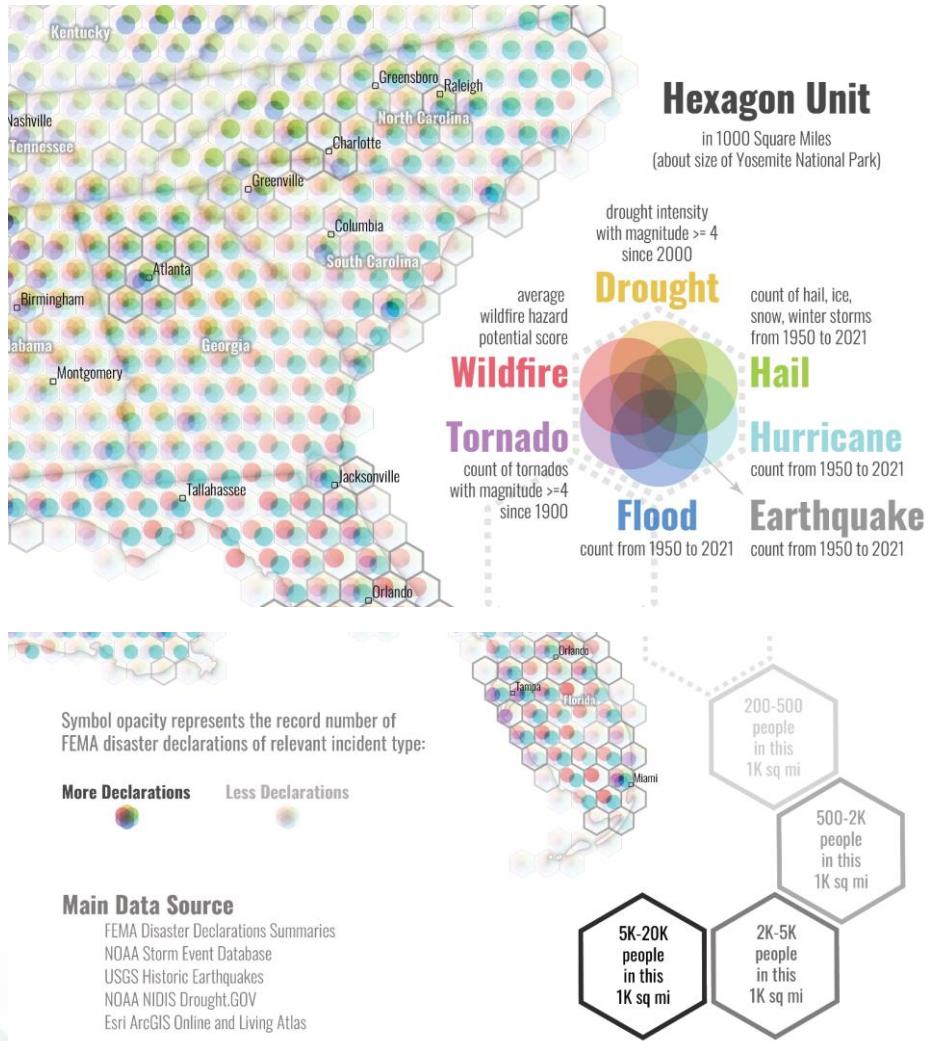
The United States of Natural Disasters

Cartography by Atlas Guo (2024) | CartoGuophy.com



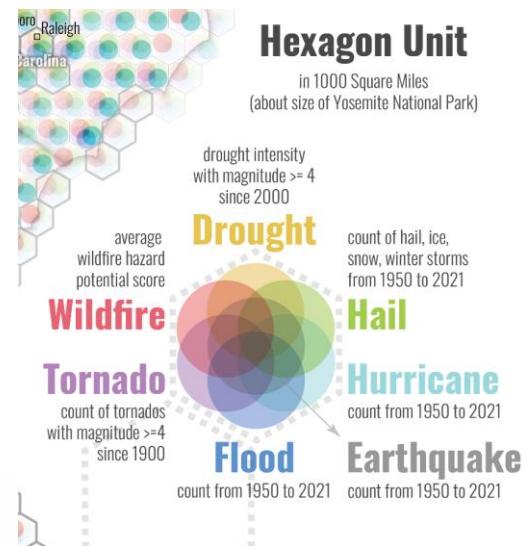
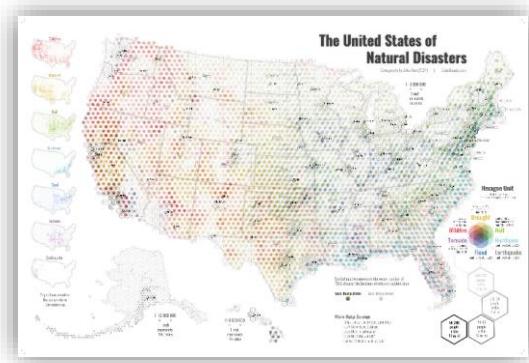
United States of Natural Disasters

- Design inspiration comes from the old printing effect, such as the dots in “halftone”
- Context: 7 major natural disasters
- 1000 sq-mile hexagon unit
- Additional: pop density (hex boundary), number of FEMA decelerations (transparency)
- Small multiples helps understand pattern
- Natural defect of color wheel (rainbow spectrum): not colorblind friendly



Symbol & Color Design

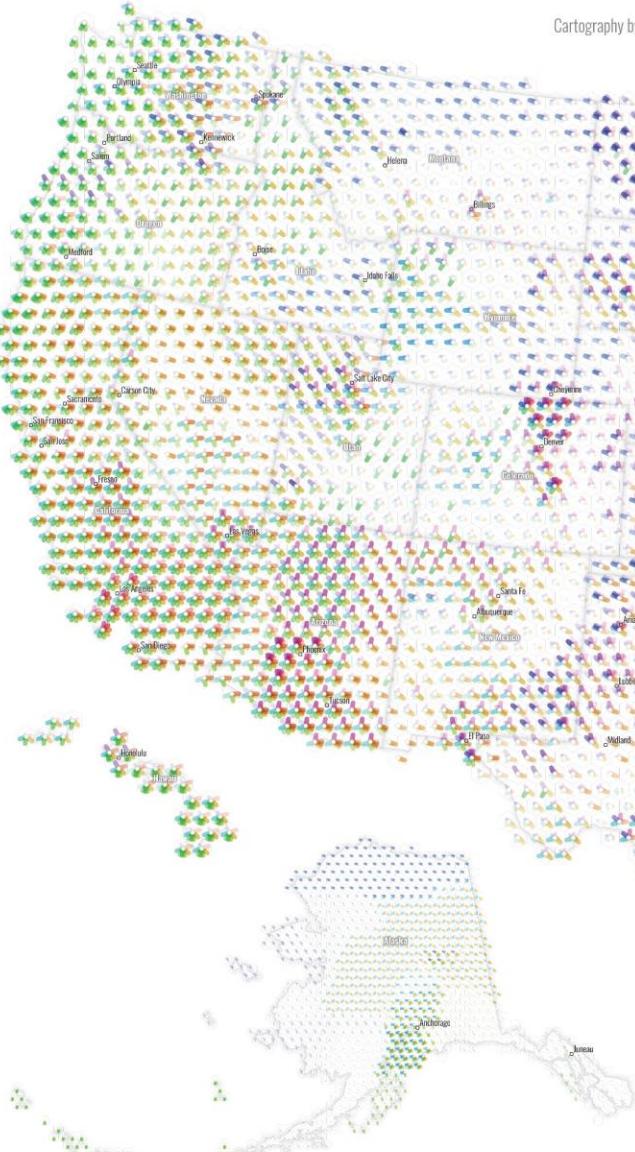
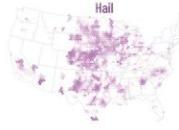
- Lightness (HSL) or value (HSV) are carefully controlled to minimize other potential variations as visual variable
- Balancing overall pattern (full overlapping) and individual attribute retrial (no overlapping) to finalize the current symbol design, with functionality and aesthetics considered
- Barely perfect solution to arrange 6 (7) natural disasters, but efforts are still made to maximize the potential cognitive association visually



The United States of Blooming Risks

An Aggregated Mosaic of FEMA National Risk Index of 18 Natural Hazards

Cartography by Atlas Guo (2024) | CartoGuophy.com



METEOROLOGICAL
(COLD)

METEOROLOGICAL
(HOT)

HYDROLOGICAL

CLIMATOLOGICAL

GEOPHYSICAL

Larger and darker petals
indicating a higher risk
of a particular hazard.



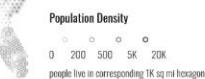
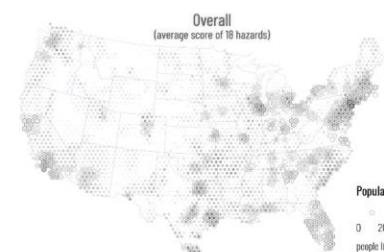
Each universal Hexagon unit in this map,
including those in all insets maps, represents
an area of 1,000 square miles.

In this floral symbol, all 18 types of hazards are
arranged along a color spectrum generally based
on mechanisms. Similar hazards are positioned
closer, visually highlighting spatial patterns.

The values within each hexagon are calculated as
the weighted average of the original risk scores
from FEMA's National Risk Index (NRI) at the
county level, with weights based on the proportion
of the area that intersects with the counties.

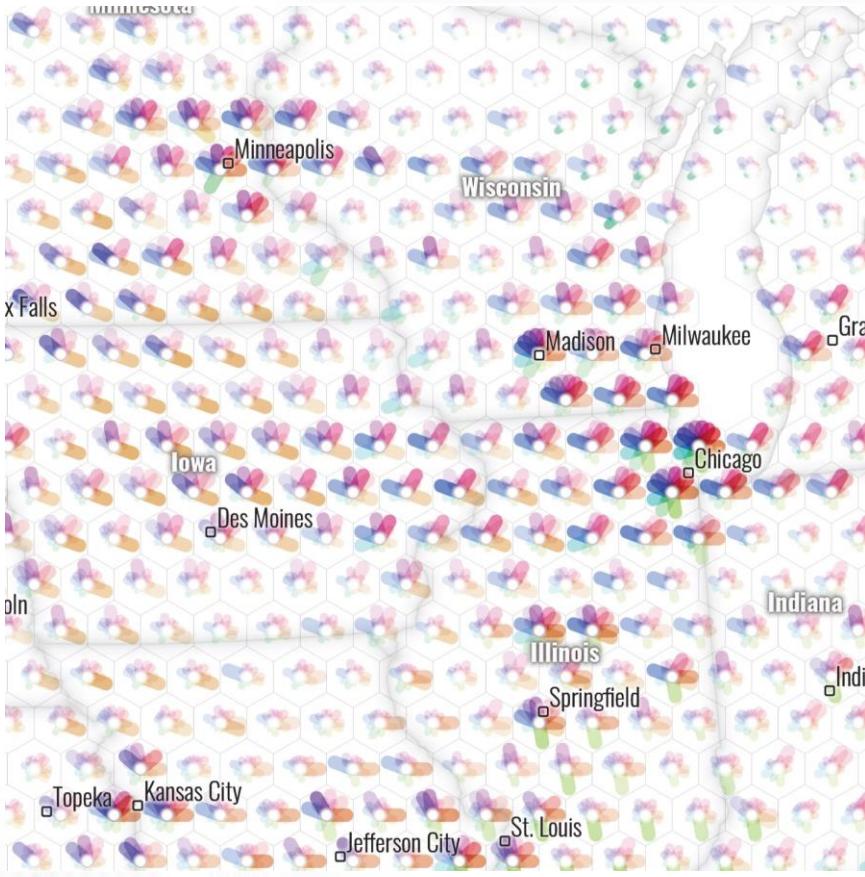
The risk score for a specific hazard is proportional
to the Expected Annual Loss from that hazard,
and the Community Resilience, while inversely
proportional to the Social Vulnerability.

To learn more about how FEMA's National Risk
Index is calculated, visit their official website:
<https://hazards.fema.gov/nri/>



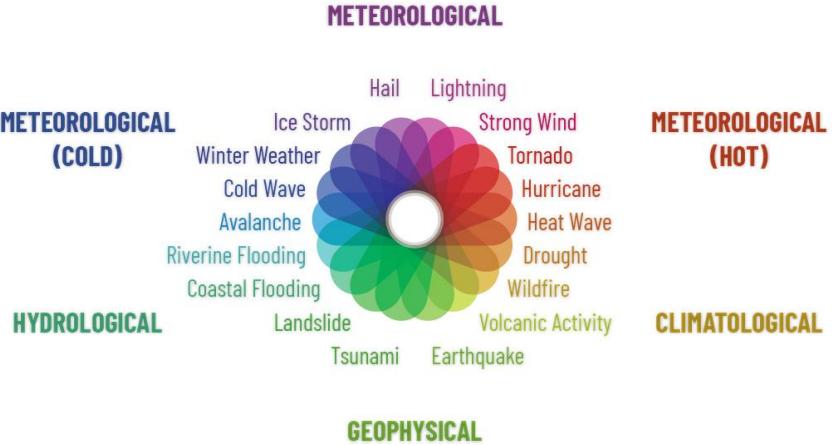
United States of Blooming Risks

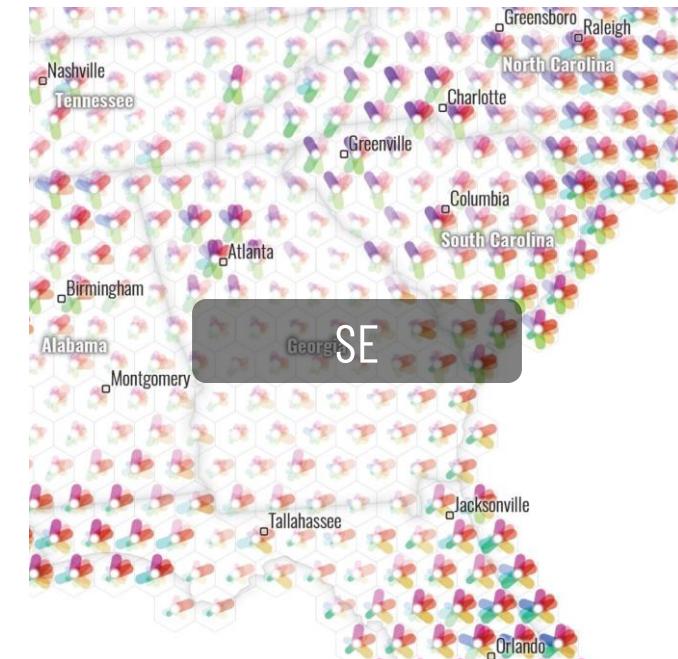
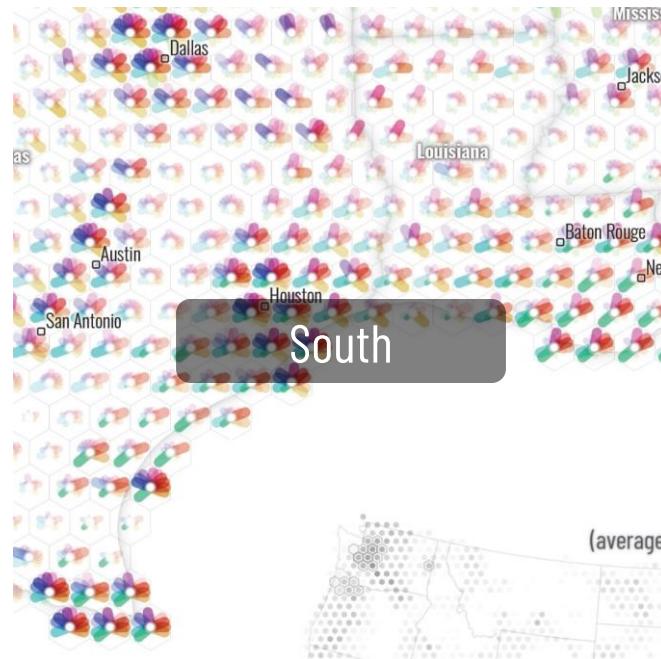
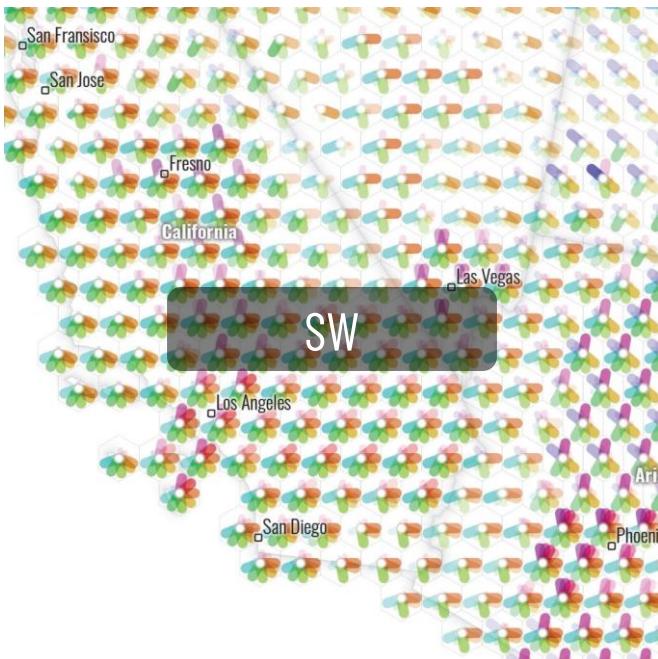
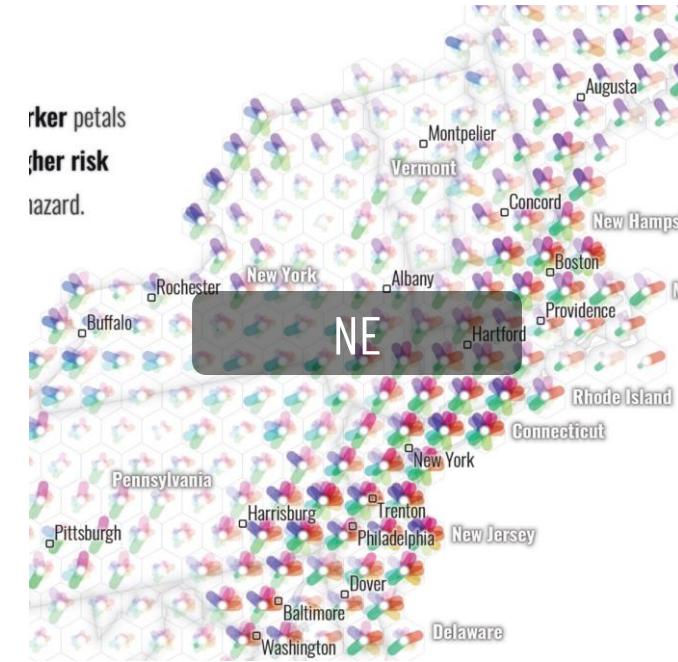
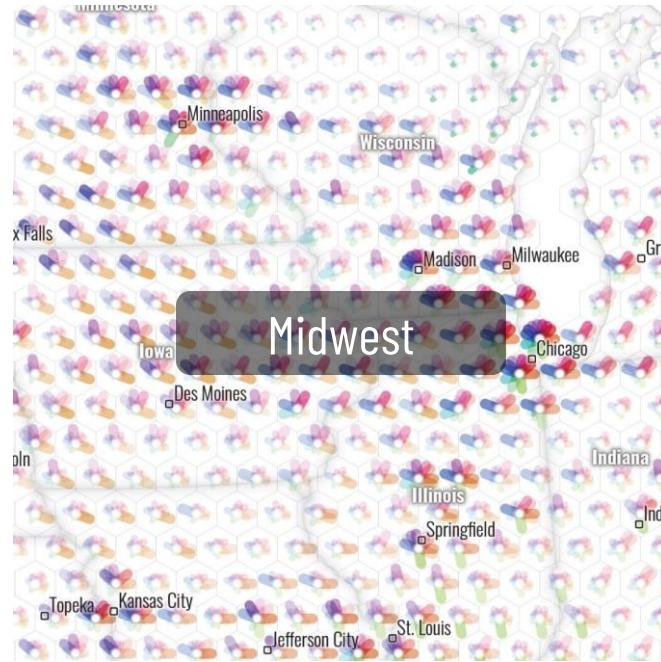
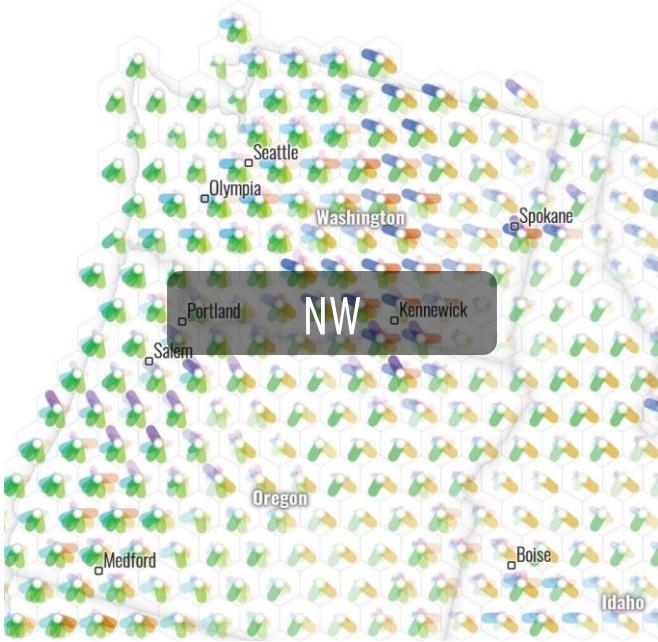
- A “Sister Map” of the previous map (sharing the same hexagon unit and even labels, similar design of symbols and layout)
- Density removed; overall pattern added
- More reliable data source from FEMA’s National Risk Index, with 18 natural hazard types
- Due to extreme high number of variables, the design of this “flourish” symbol of “blooming risks” becomes extremely critical, e.g. level of overlapping, arrangement, color selection



AI-Assisted Cartographic Design

- Instead of stand color wheel, ChatGPT is used to generate a customized color wheel, where the orange part (red-to-yellow) is expanded, due to human eyes' stronger cognition
- FEMA simply lists 18 hazards alphabetically, without sequential order or hierarchy
- ChatGPT is used to describe the mechanism and characteristics of the hazards, create similarity matrix quantitatively, and generate a circular order with similar ones as close to each other as possible (a manual adjustment is always needed)

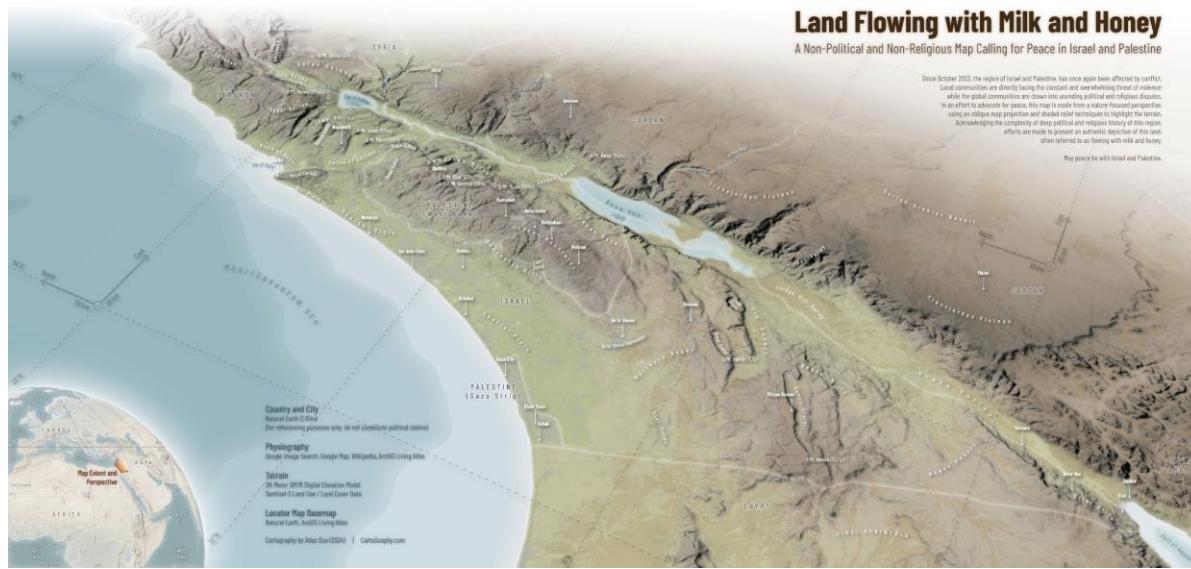




Scenic Formosa Island

Zibo Map of Culture and Tourism

Theme 3 - Reference Map Hillshading



Israel & Palestine



Taiwan



Zibo

Hillshading Methodology

- Credit to John Nelson's videos (slightly different)
 - Required (DEM) data: 30-Meter SRTM Elevation Data
 - Optional data: satellite imagery, land use land cover, bathymetry, contour lines (generated from DEM)
- 20-30 Layers with various blend mode and transparency
 - Original DEM (Normal)
 - Layer Group (Overlay / Luminosity)
 - Hillshade of slope of original DEM (Overlay / Soft Light; Invert Color)
 - Hillshades of original+blurred DEMs (Soft Light)
 - Slopes of original+blurred DEMs (Multiply / Soft Light; Invert Color)
 - Original+blurred DEMs (Normal)
 - Satellite imagery and/or land use land cover (Normal)



SCENIC FORMOSA ISLAND

A Non-Political Map of Taiwan in Three Scripts

美麗之島・福爾摩沙

美麗之島・福爾摩沙 美丽之岛・福尔摩沙

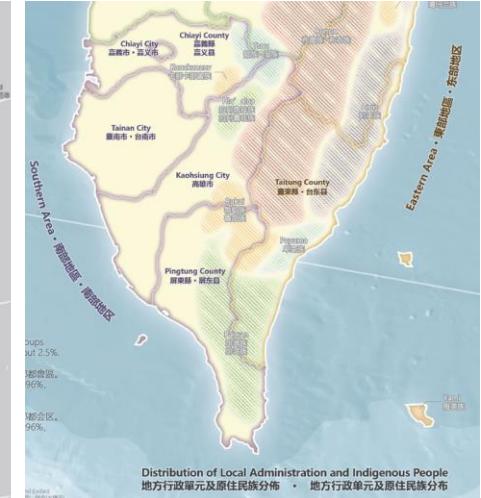
無關政治的臺灣地圖(英/繁/簡)

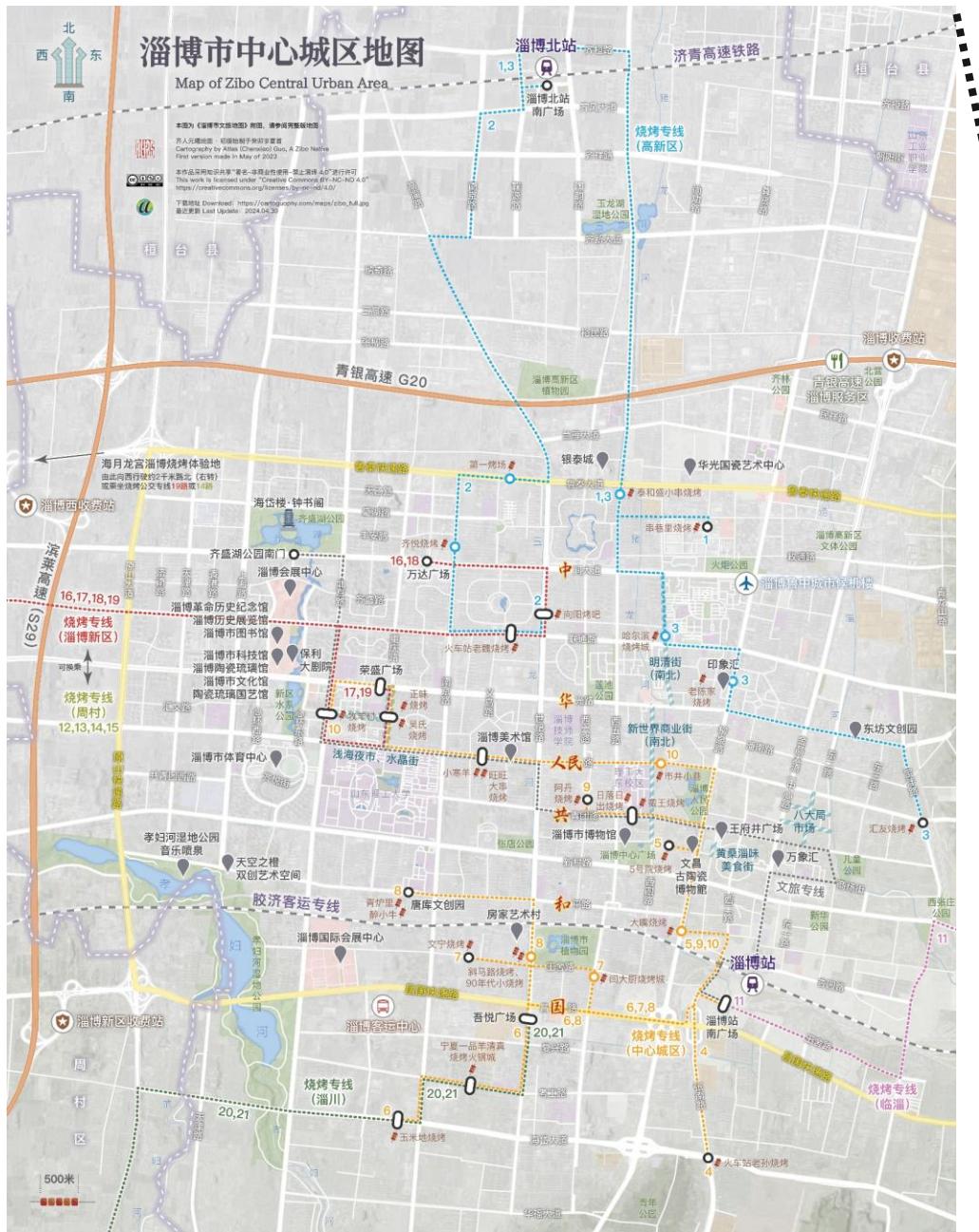
无关政治的台湾地图(英/繁/简)



Scenic Formosa Island (Taiwan)

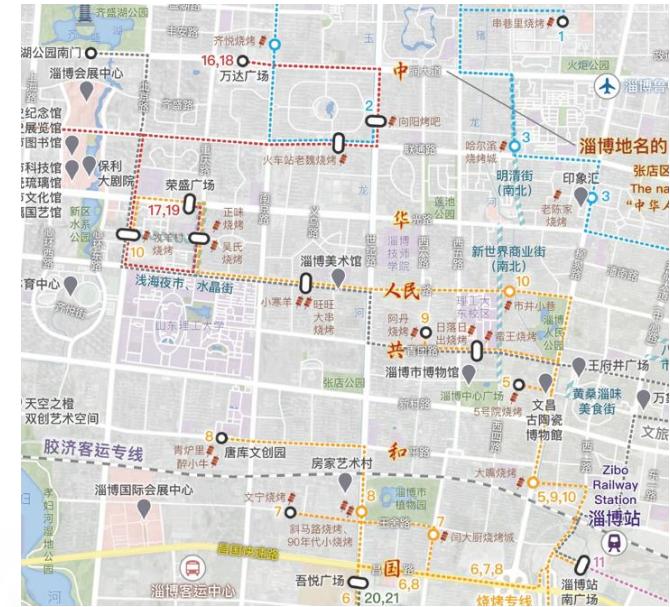
- Projection: “Earth from Space” (orthographic) to best show the terrain pattern (lower in west; high in east) while still generally keeping common cognition of “North is Up”
- Trilingual (3-script): English + traditional and simplified Chinese characters
- Non-political (focusing on natural features)
- Locator map indicates the viewing extent
- Top-right inset shows the administrative units and distribution of indigenous groups





Zibo Map of Culture and Tourism

- Focusing on POIs and transportation related to culture and tourism
- Inset maps of central urban area (street map), and a locator map of the province (also with hillshading)
- Various graphic designs from cultural and historical elements, such as north arrow, scale bars
- Transit map style symbols for special bus routes
- Full of passion as a native

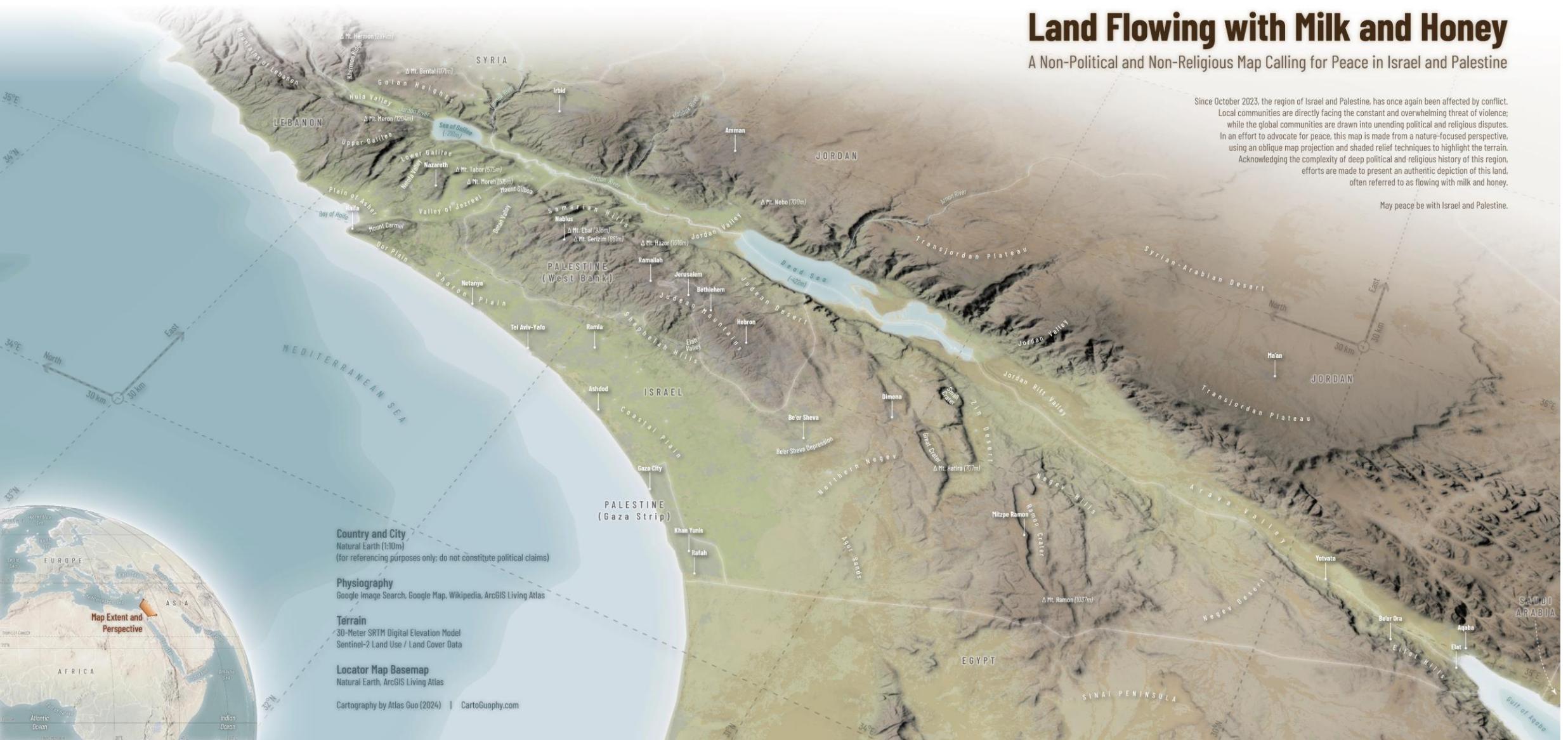


Land Flowing with Milk and Honey

A Non-Political and Non-Religious Map Calling for Peace in Israel and Palestine

Since October 2023, the region of Israel and Palestine, has once again been affected by conflict. Local communities are directly facing the constant and overwhelming threat of violence; while the global communities are drawn into unending political and religious disputes. In an effort to advocate for peace, this map is made from a nature-focused perspective, using an oblique map projection and shaded relief techniques to highlight the terrain. Acknowledging the complexity of deep political and religious history of this region, efforts are made to present an authentic depiction of this land, often referred to as flowing with milk and honey.

May peace be with Israel and Palestine.



Land Flowing with Milk & Honey (Israel & Palestine)

- Oblique view in Scene
 - Balancing terrain pattern and common cognition
 - Gaza strip at the center (focus of conflict when I made it)
 - Not recommended due to non-editable export
- Represent the landscape with land use / land cover data
- Non-political and non-religious map:
 - Minimum inclusion of political elements
 - Modern place names of physical features
- Farther areas fade out like mist

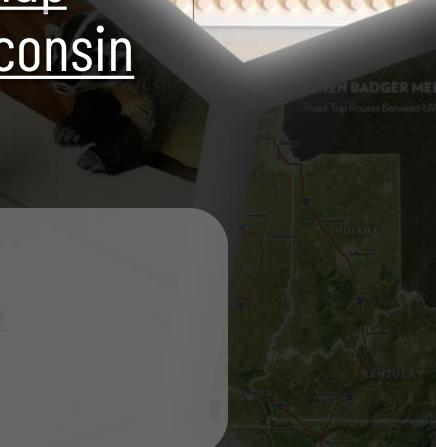
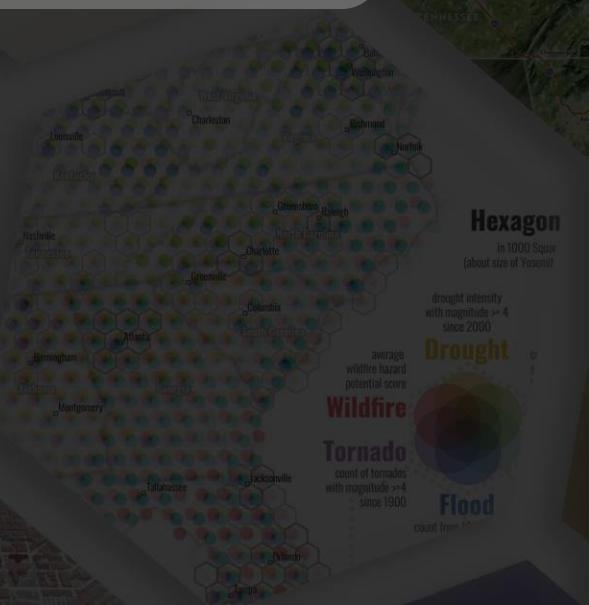
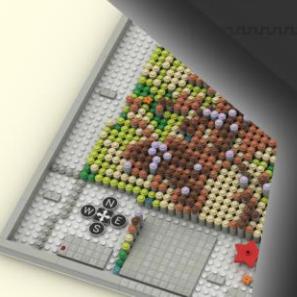


LEGO Map of Wisconsin

Theme 4 - LEGO Style Map Design

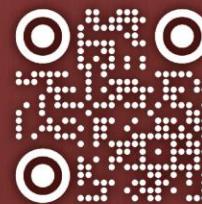
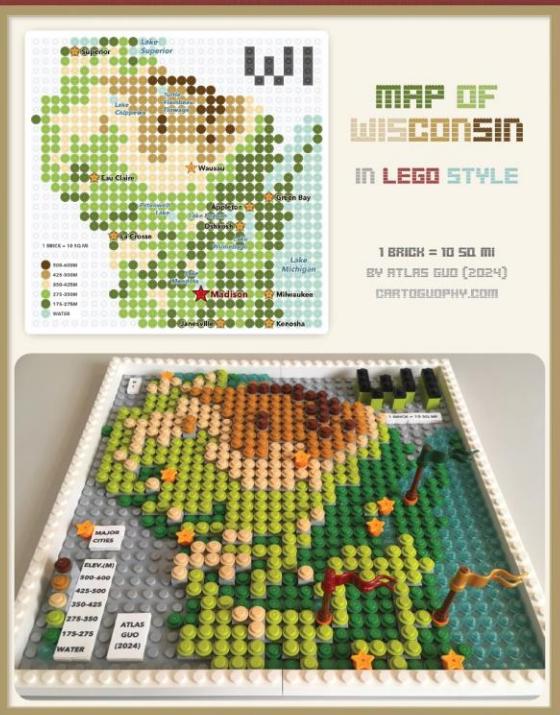
LEGO Map of Colorado

LEGO
MAP OF



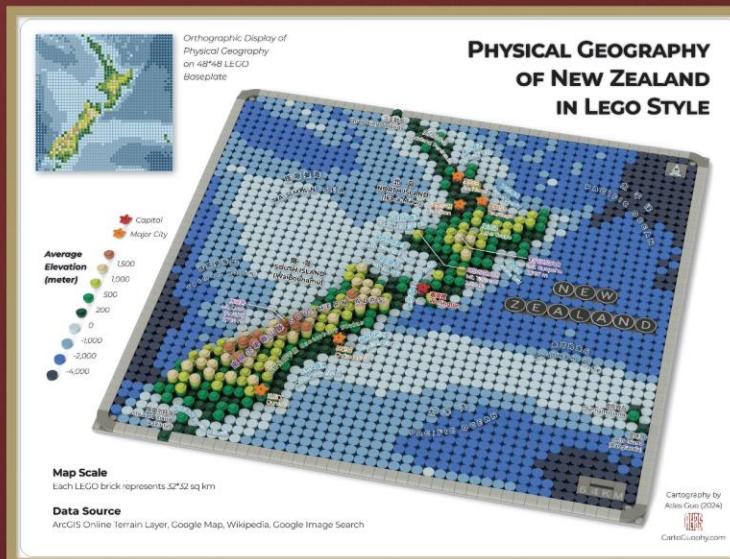
Atlas (Chenxiao) Guo
toGuophy.com





A MINI GALLERY OF LEGO TOPOGRAPHIC MAPS

Design by Atlas Guo (2024) | CartoGuophy.com
Scan the QR Code to view each map with introduction



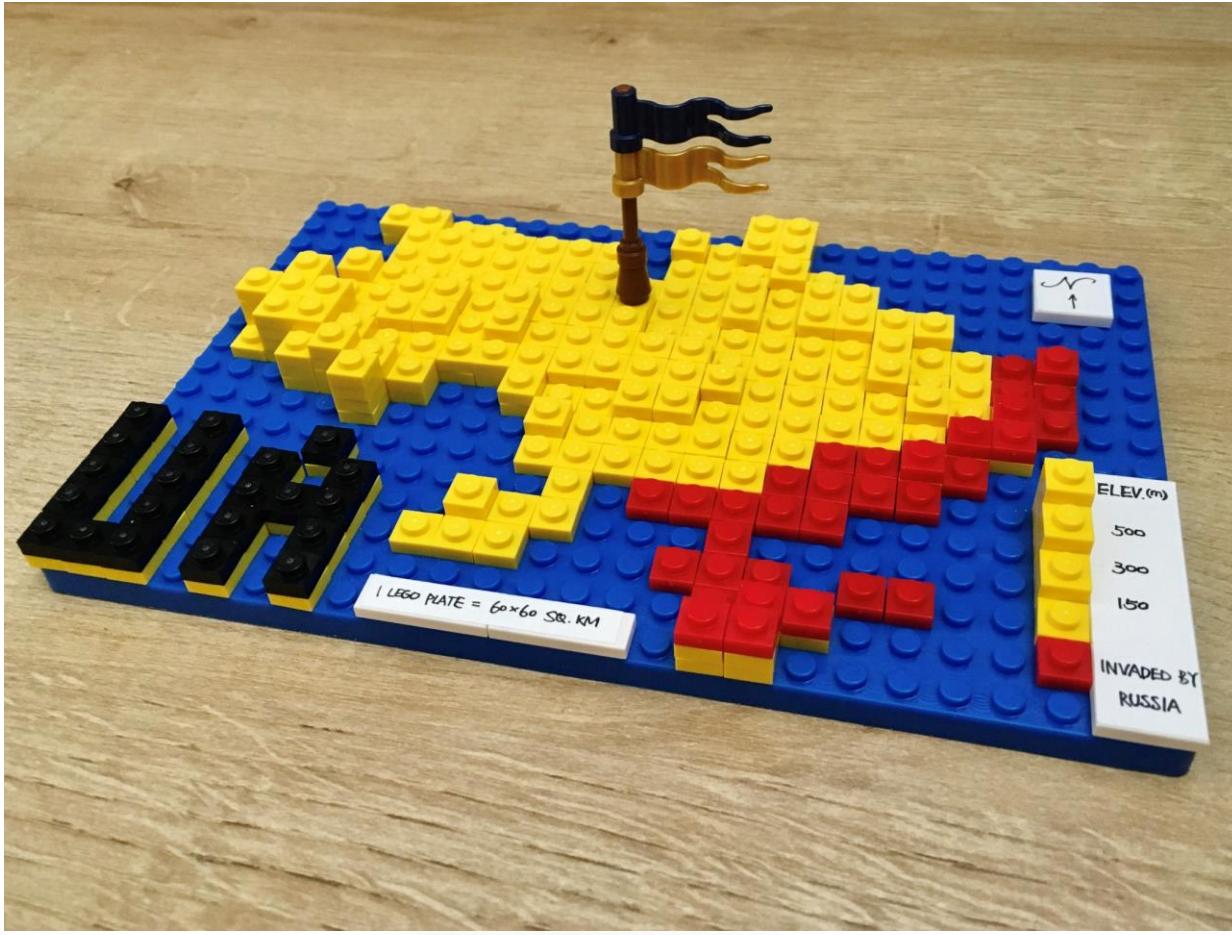
LEGO Style Topographic Map Design

- Significant difference between any two of them (always trying different design)
- Similar workflow and design style (in ArcGIS Pro)
 - Plan visually (and calculate) considering baseplate, scale, and extent
 - Generate fishnet and extract values from DEM
 - Apply LEGO-style symbology, including classification and symbolization
 - Buy elements accordingly to build the physical LEGO, or built up virtually in LEGO Studio (app)
- For detailed methodology and some discussions from a cartographic perspective, view my previous 8-minute presentation in NACIS 2024, and hour-long presentation for GIS Colorado

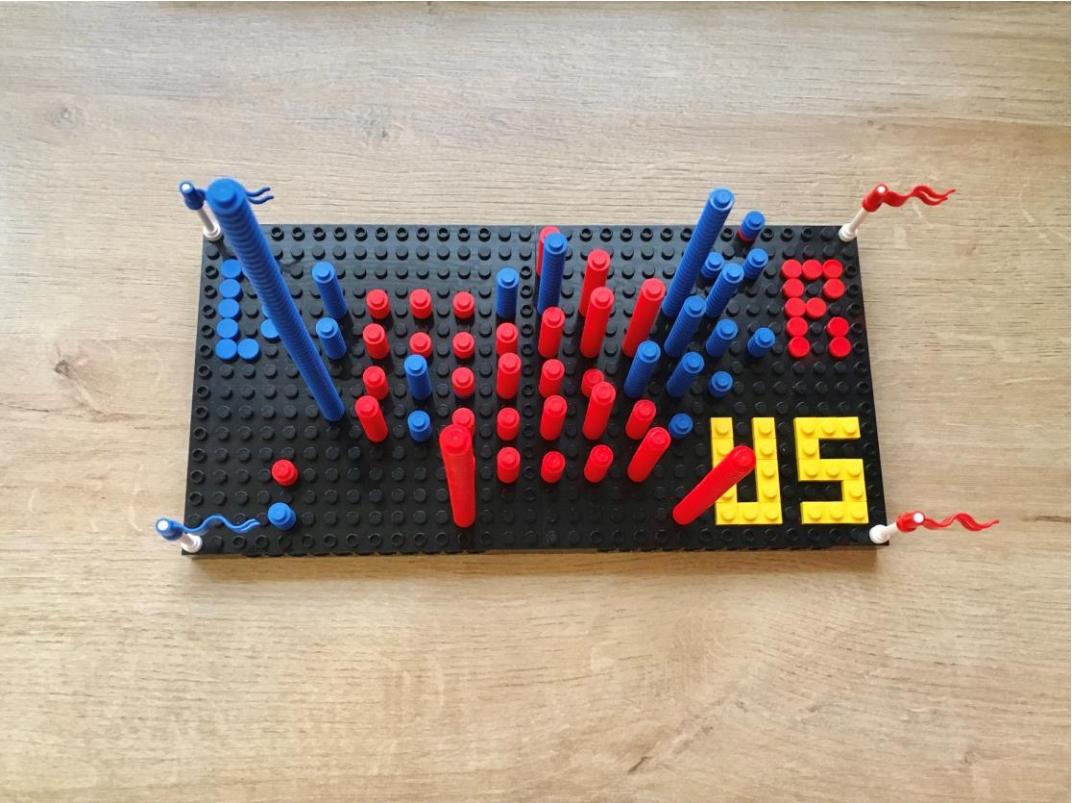
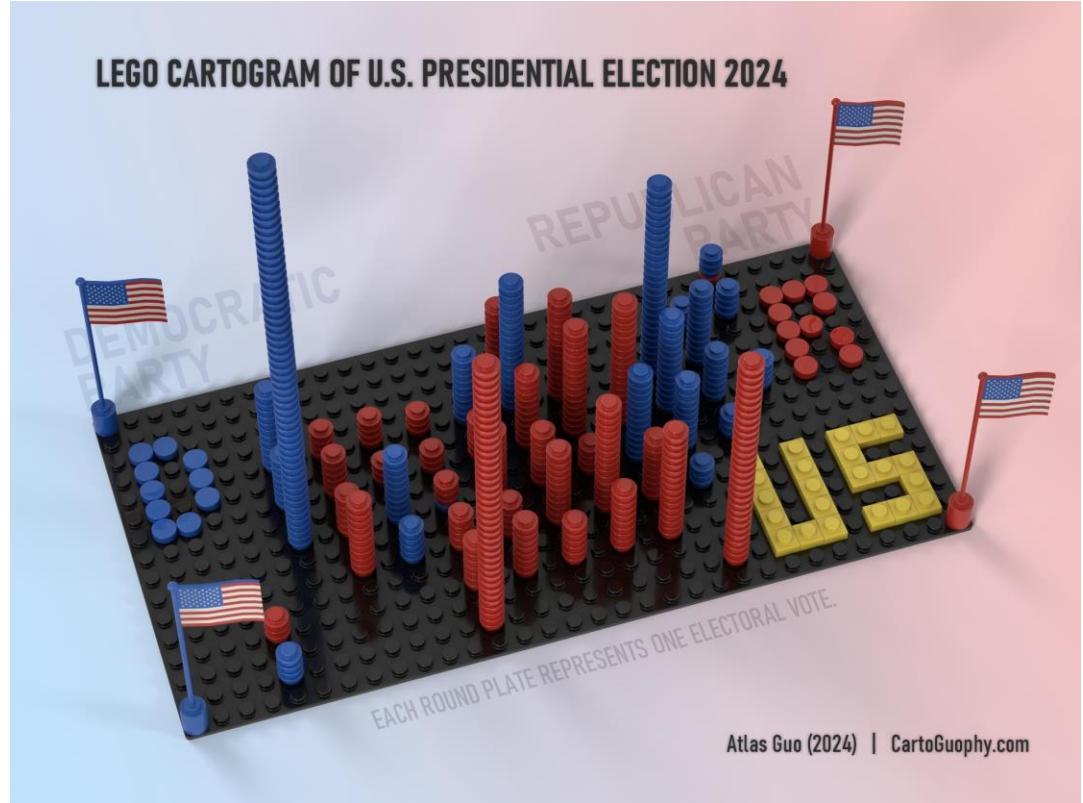
LEGO Maps of Wisconsin and North America

- YouTube Video: <https://youtu.be/P-ueG7kW7nA>

3D Map of Ukraine with Invaded Area (terrain raised)



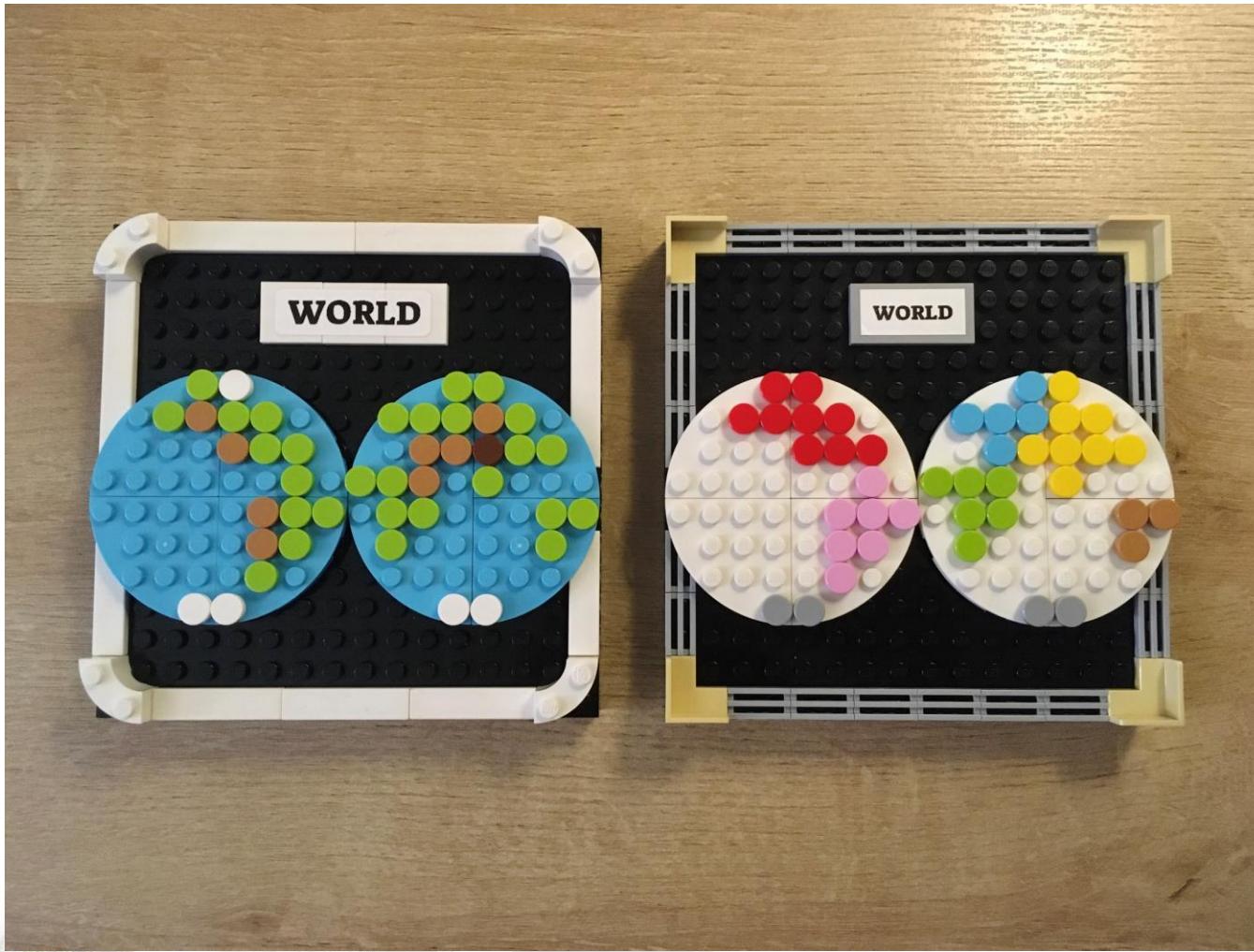
Cartogram of U.S. Presidential Election 2024



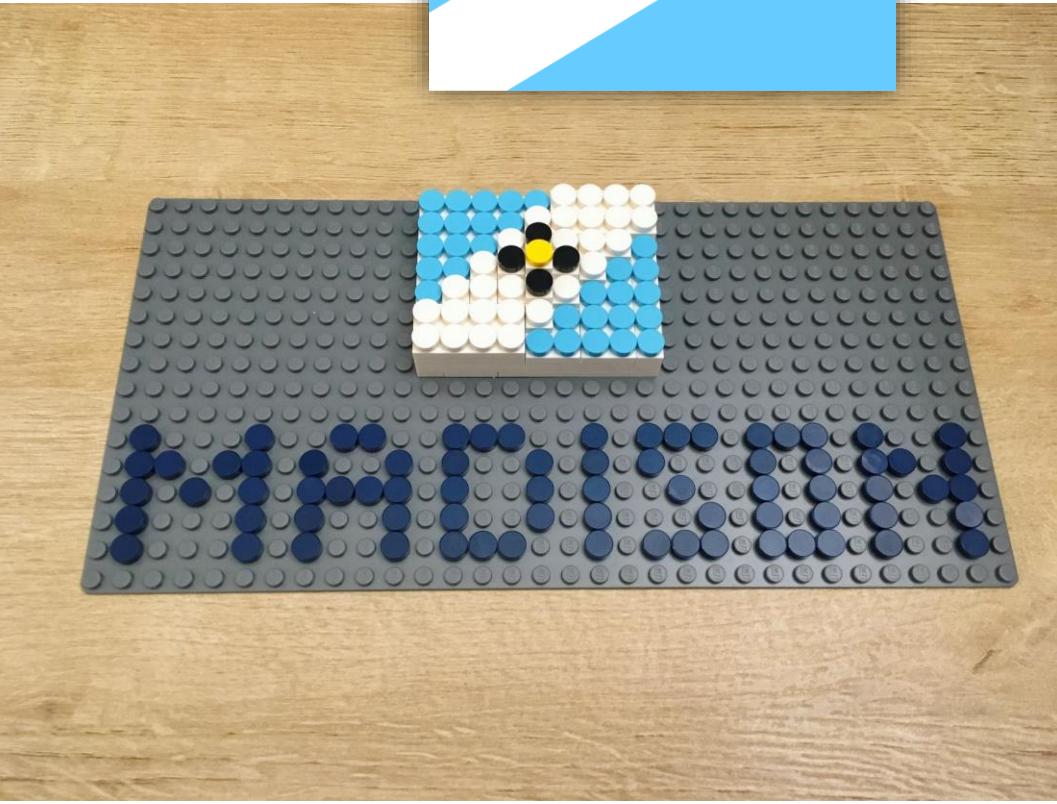
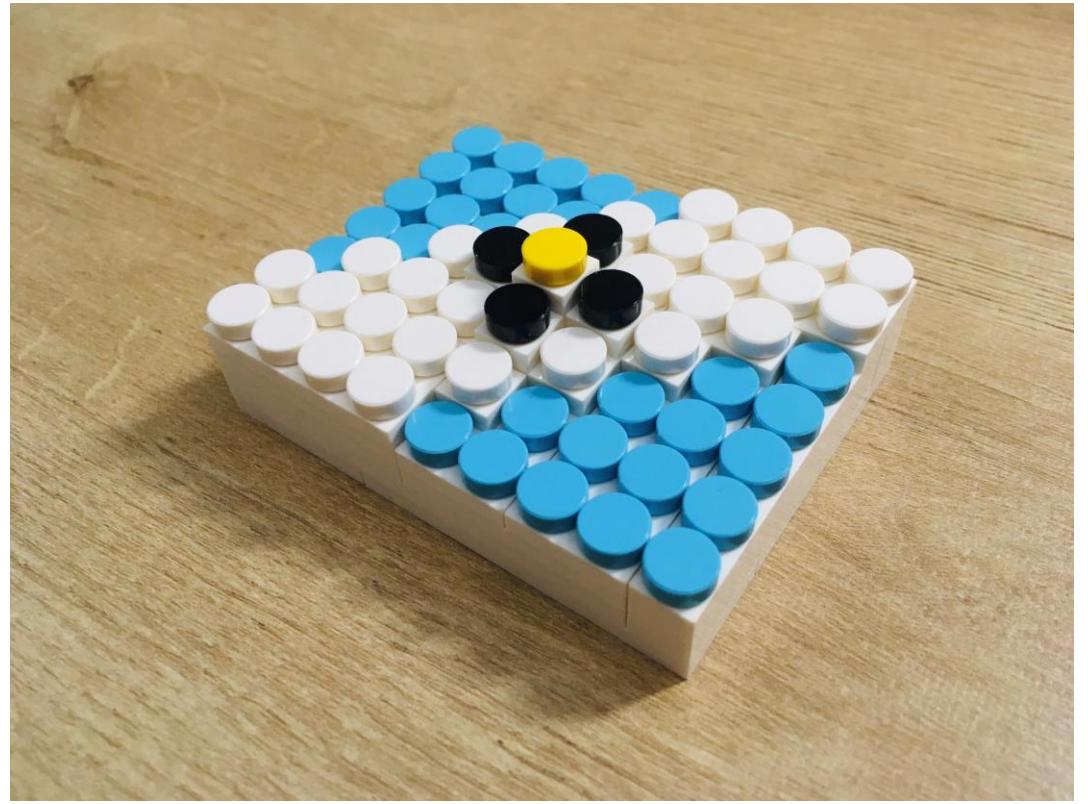
Cartogram of U.S. Presidential Election 2024

- YouTube Video: <https://youtu.be/sjb1aZVPdk>

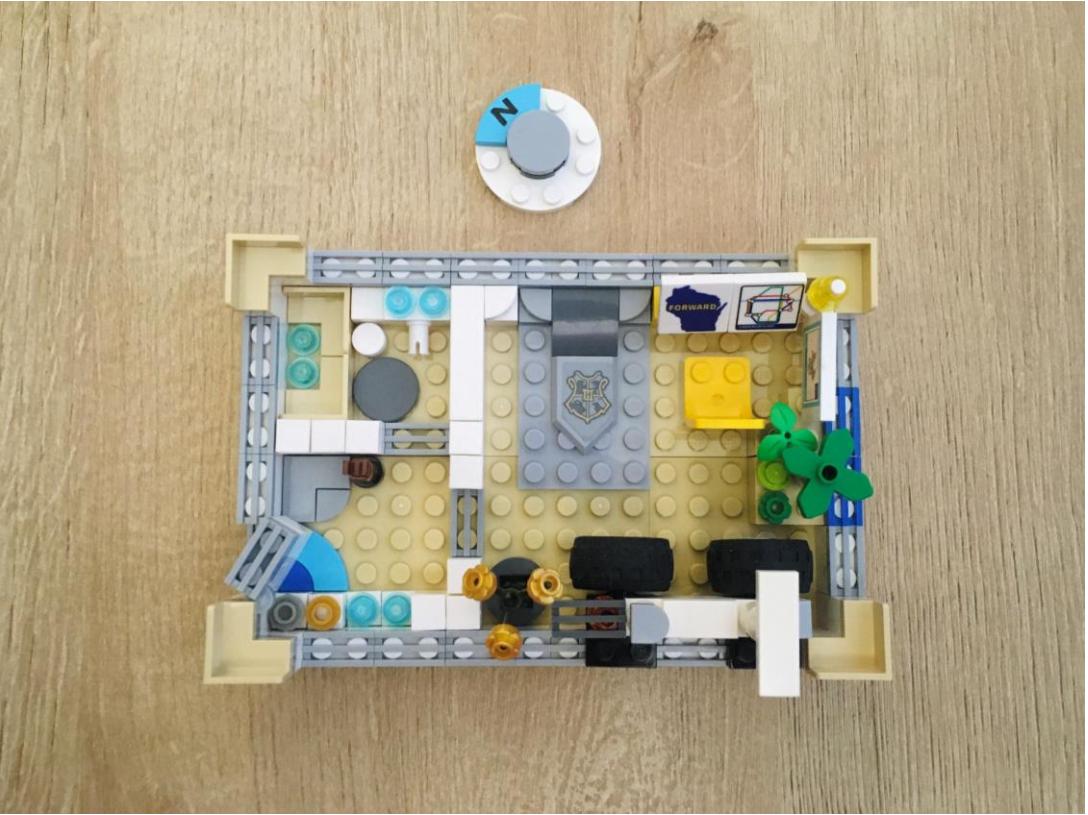
Hemisphere World Map (Physical and Continental)



3D Version of Madison Flag Map



Micromapping of My Room



Outro

Summary

- Enjoy the process, not only the “final” version
- Learn from others (inspiration; shortcut; methodology)
- Combine existing experiences, e.g.: seal-carving (layout, hillshading), calligraphy (typography), painting (color), cycling/running tracks (personal memories/experiences), crafts (a lot!)
- Practice in November’s 30-Day Map Challenge (clearing up unfinished maps, updating existing ones, trying new craft maps)
- Our cartographic journey never ends!

UW-Madison GIS Professional Programs - **Map Chat** Guest Talk

THANK YOU!

- - - Keep Calm and Map On! - - -



Atlas Guo

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