

Joint Environment Committee and Housing Committee Meeting  
Resilience to Extreme Heat  
16 April 2024



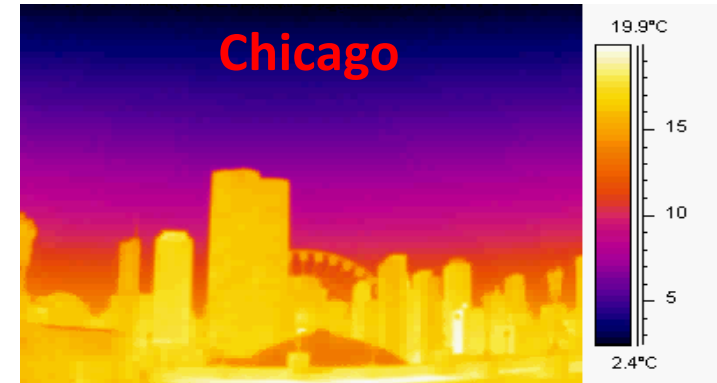
# e-JUST: Environmental Justice using Urban Scalable Toolkit



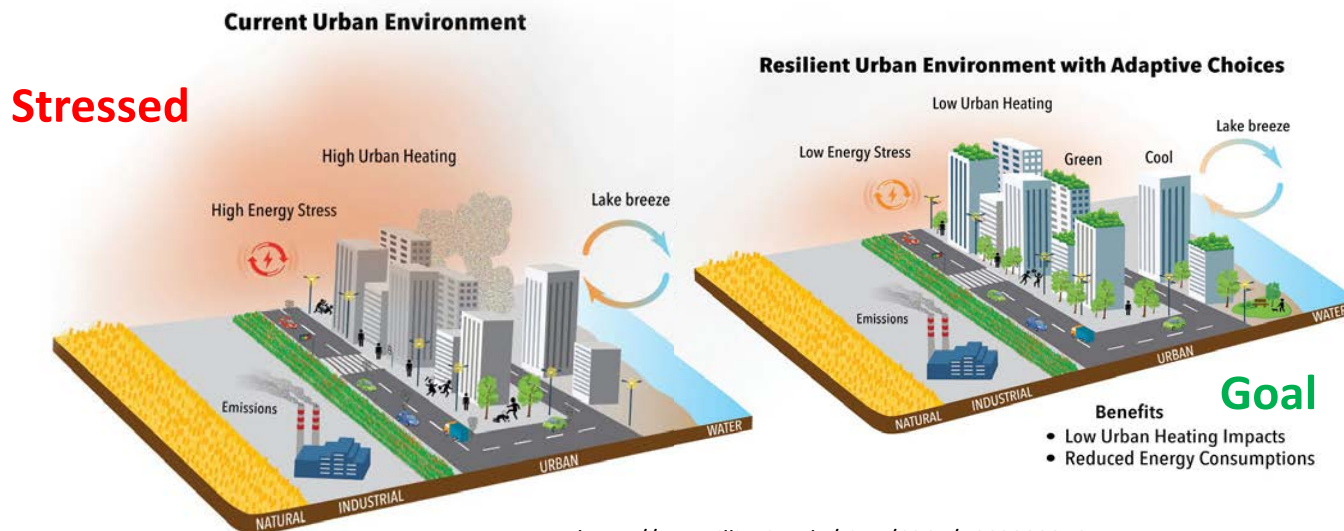
**Ashish Sharma**  
*Climate and Urban Sustainability Lead  
Discovery Partners Institute, University of Illinois System*

# Urban systems

Multiscale, interdependent, social, natural, and engineered complex systems.



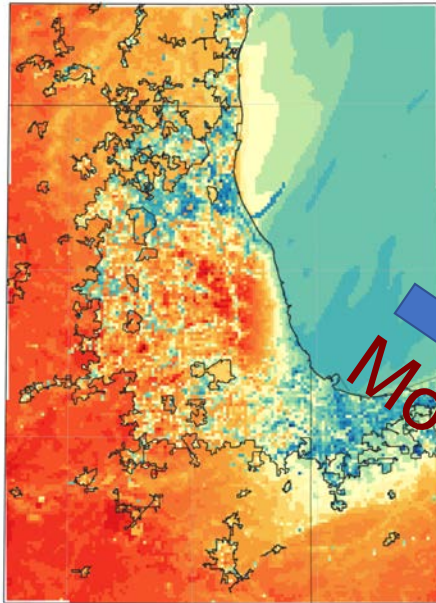
Kristovich et al., (2019) *Meteorol. Monogr.*



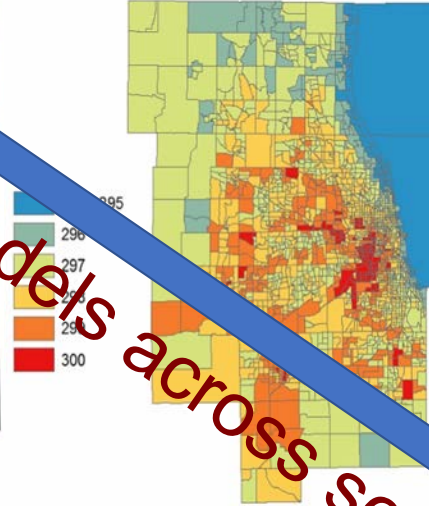
<https://news.illinois.edu/view/6367/1668083379>

# Computer (climate) urban models

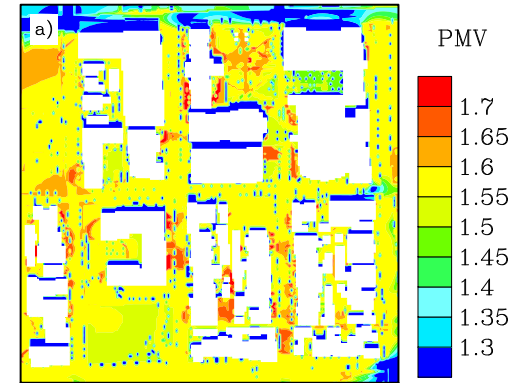
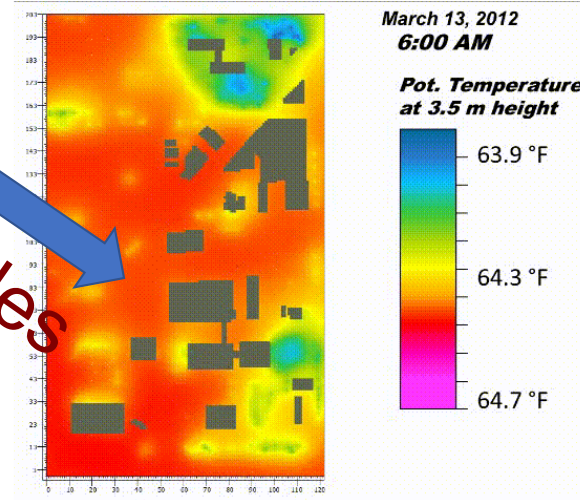
## Regional-scale models



## City-scale models



## Neighborhood models (2 m resolution)



Conry et al. (2015) *JAMC*

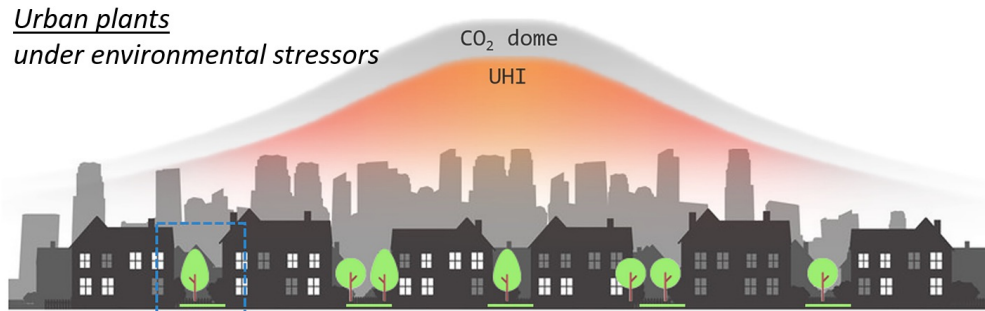
Models across scales

# Urban vegetation – trees, urban parks forests, etc.

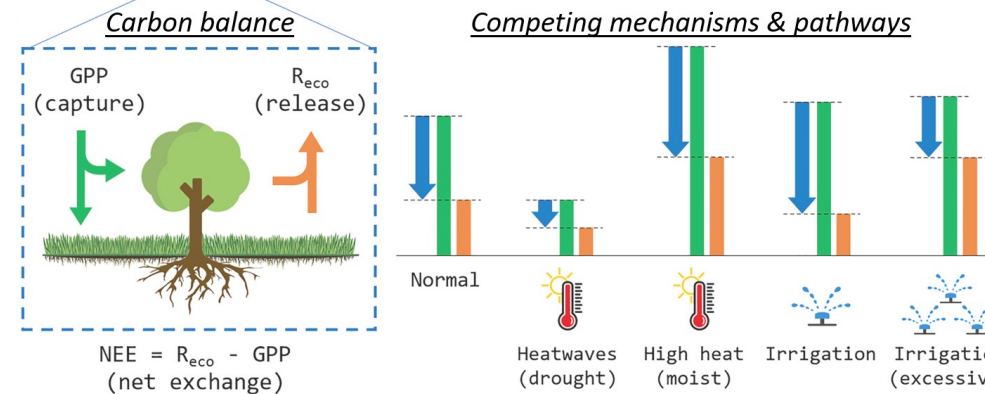
Atmosphere

Land surface

Sub-surface



*Environmental perturbation: Heatwaves*



*Anthropogenic perturbation: Irrigation*



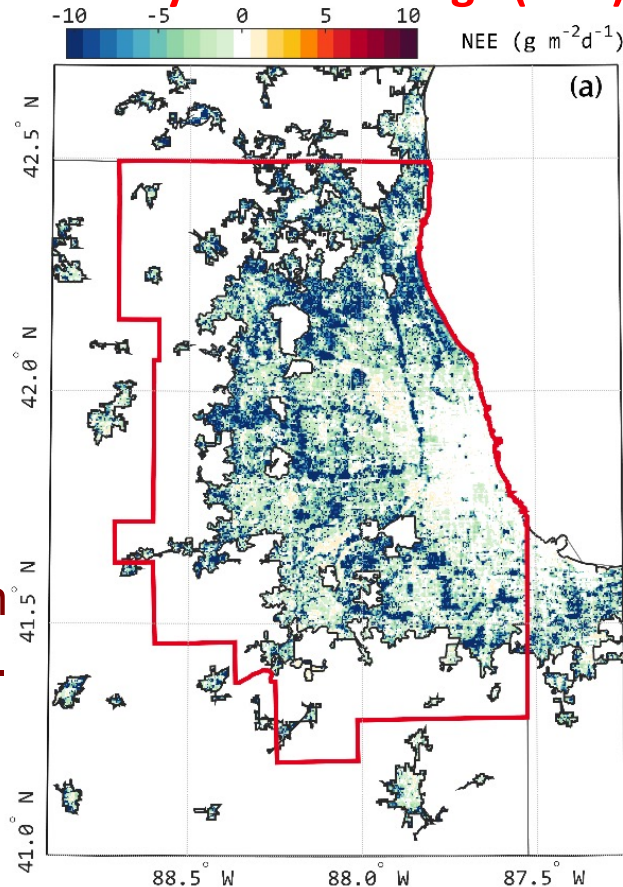
## Carbon exchange in urban areas

- Passive impacts from heat and elevated background CO<sub>2</sub> level alter growth of plants.

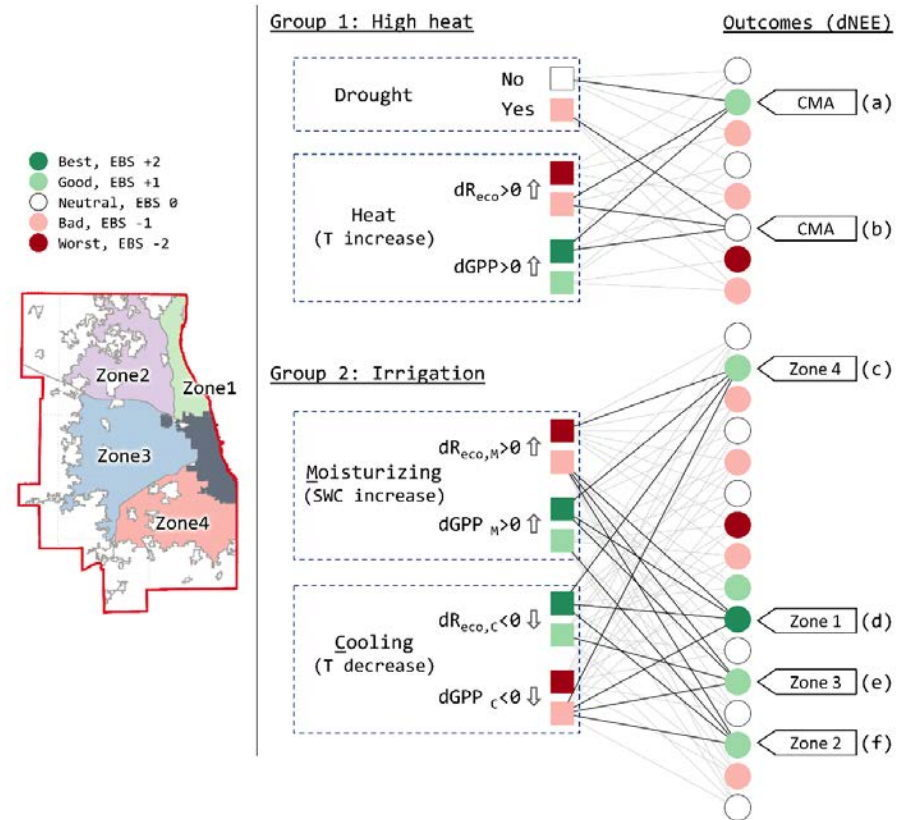
# Changes in CO<sub>2</sub> due to urban vegetation

- High spatial variability
- Active CO<sub>2</sub> sequestration in urban parks, followed by vegetated land in residential areas.

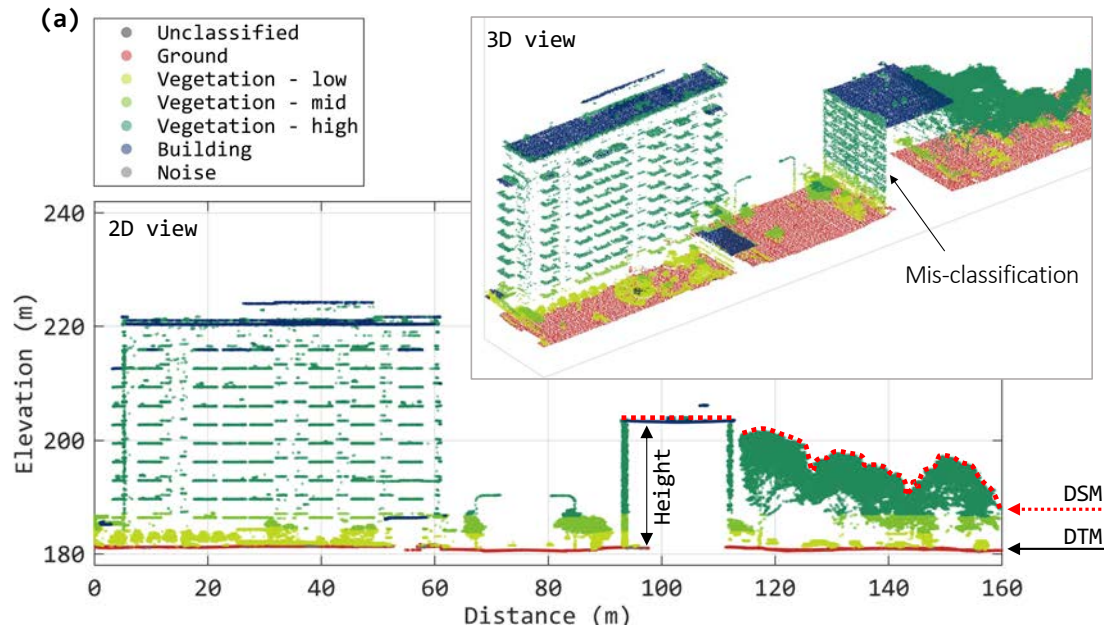
## Net ecosystem exchange (NEE)



## Environmental benefit score

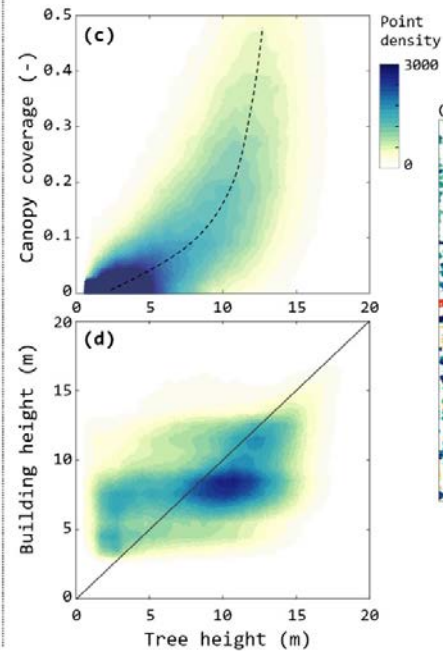
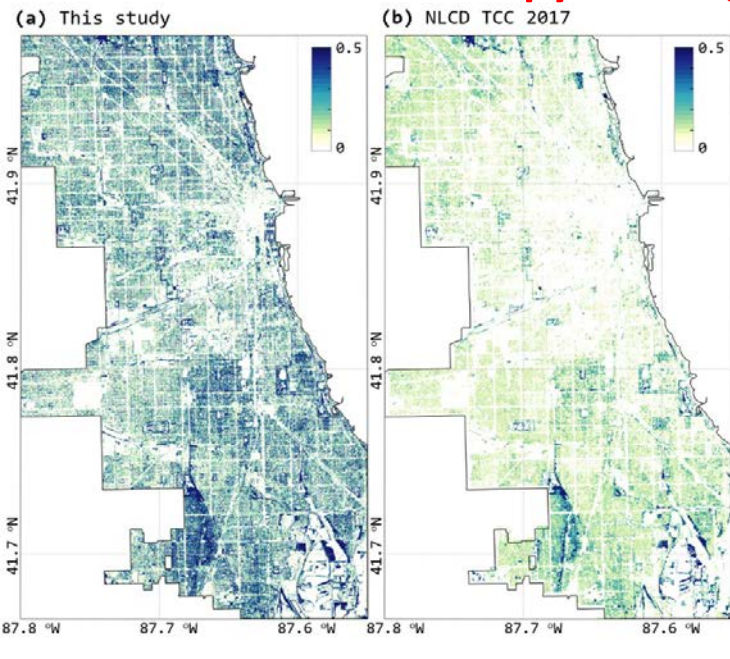


- LiDAR data at an exemplary street block

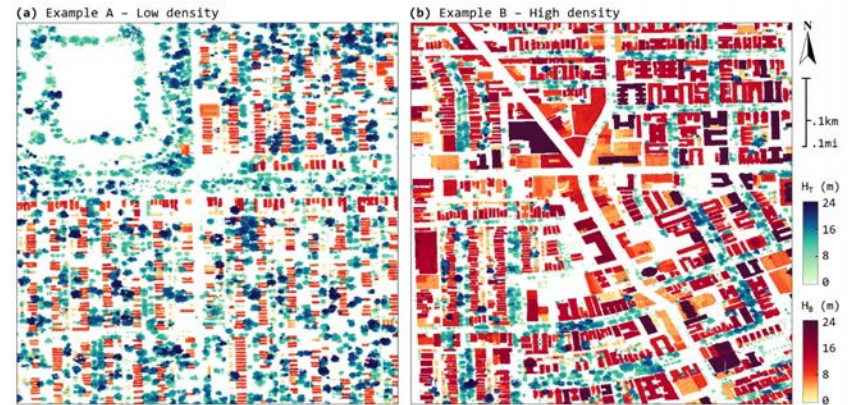


# HiTAB-Chicago: Height map of Trees And Buildings for the City of Chicago

## Tree canopy coverage



## Building height



Open-source data available at:  
<https://doi.org/10.5281/zenodo.10463648>

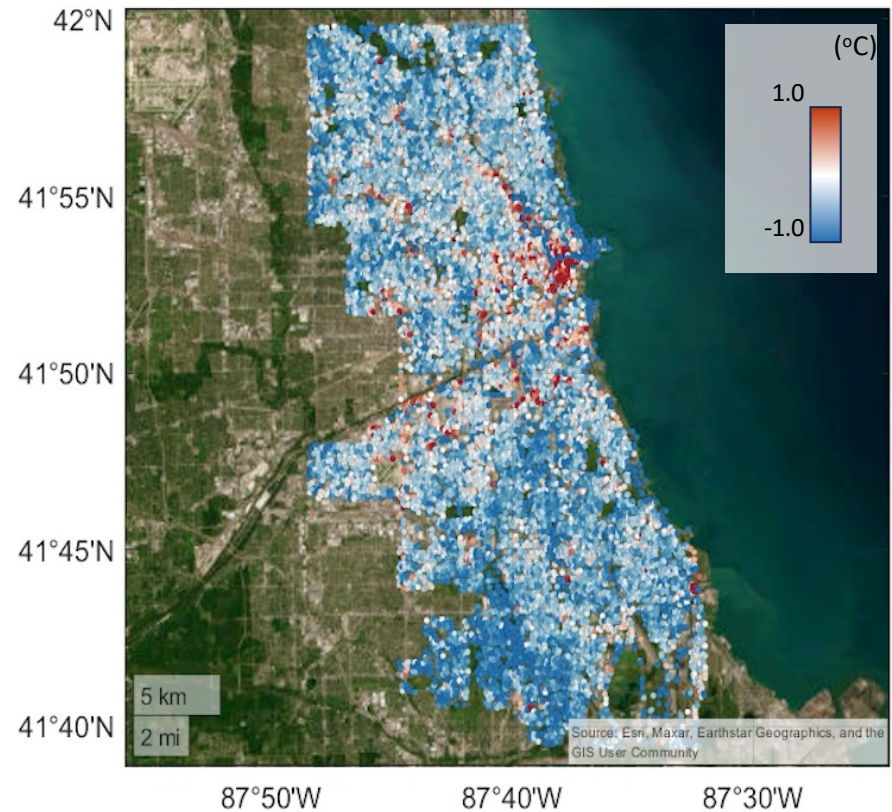
# Solutions at scales it matters



- A physical-informed machine learning framework to estimate street-level environmental stressors

Li and Sharma (2024), JAMES

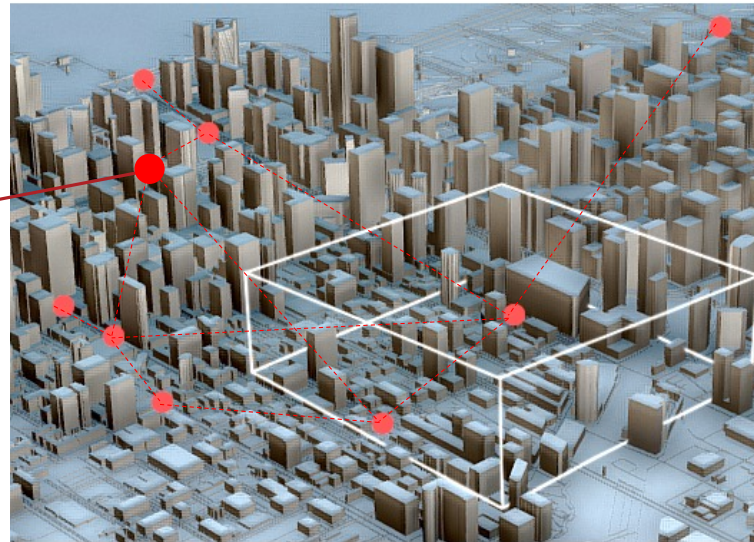
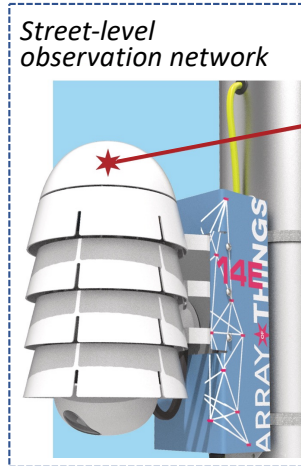
Temperature deviation from areal mean (hourly)



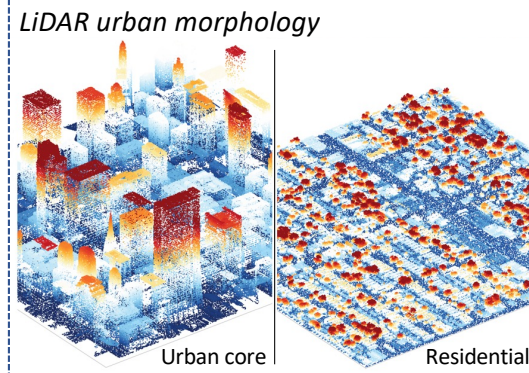
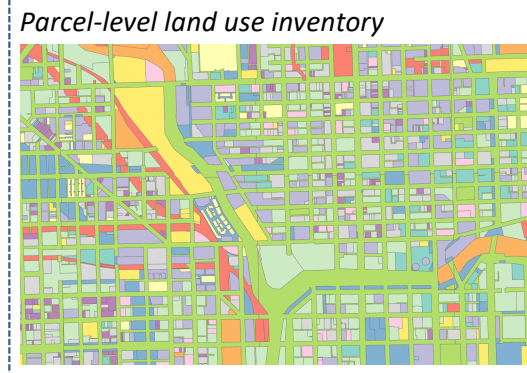
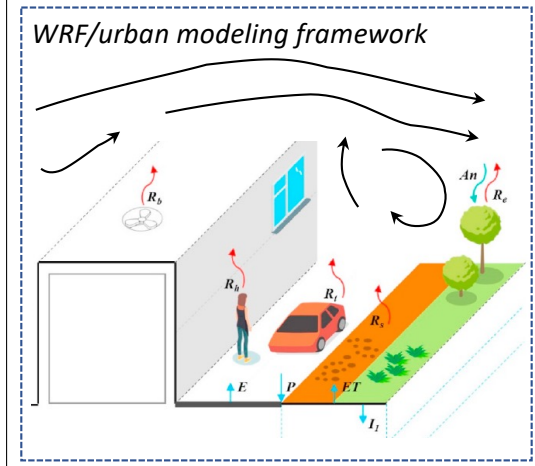


# Urban informatics

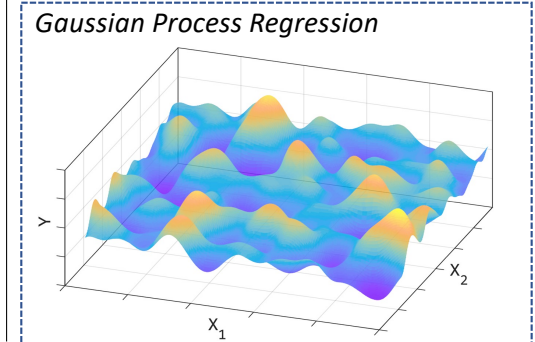
Li and Sharma (2024), JAMES (in press)



## Urban Weather Forecast

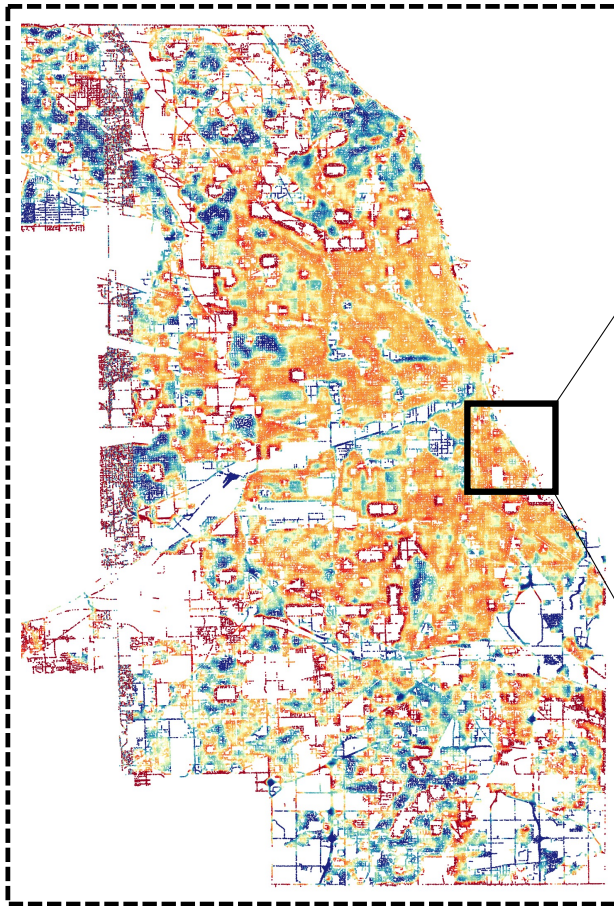


## Machine Learning

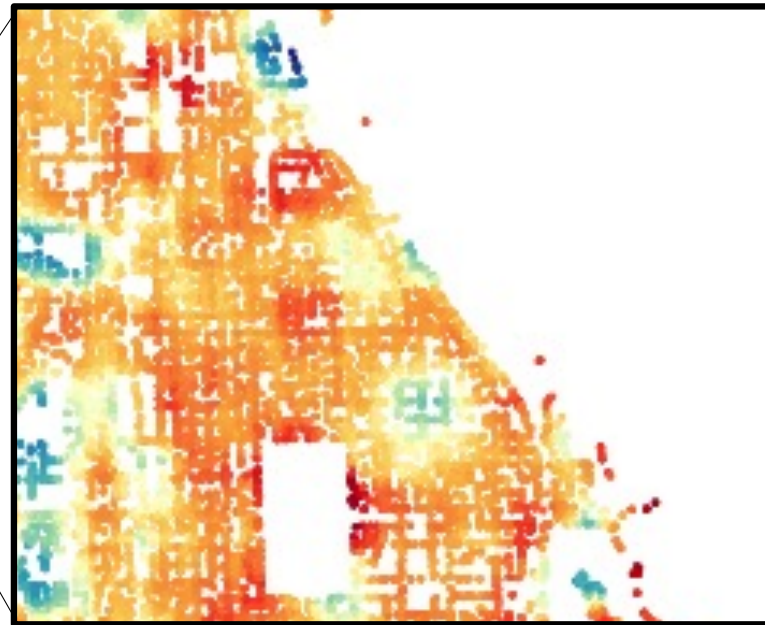


- Forecasting street-level temperature via data fusion of urban informatics

# Street-level temperature estimation



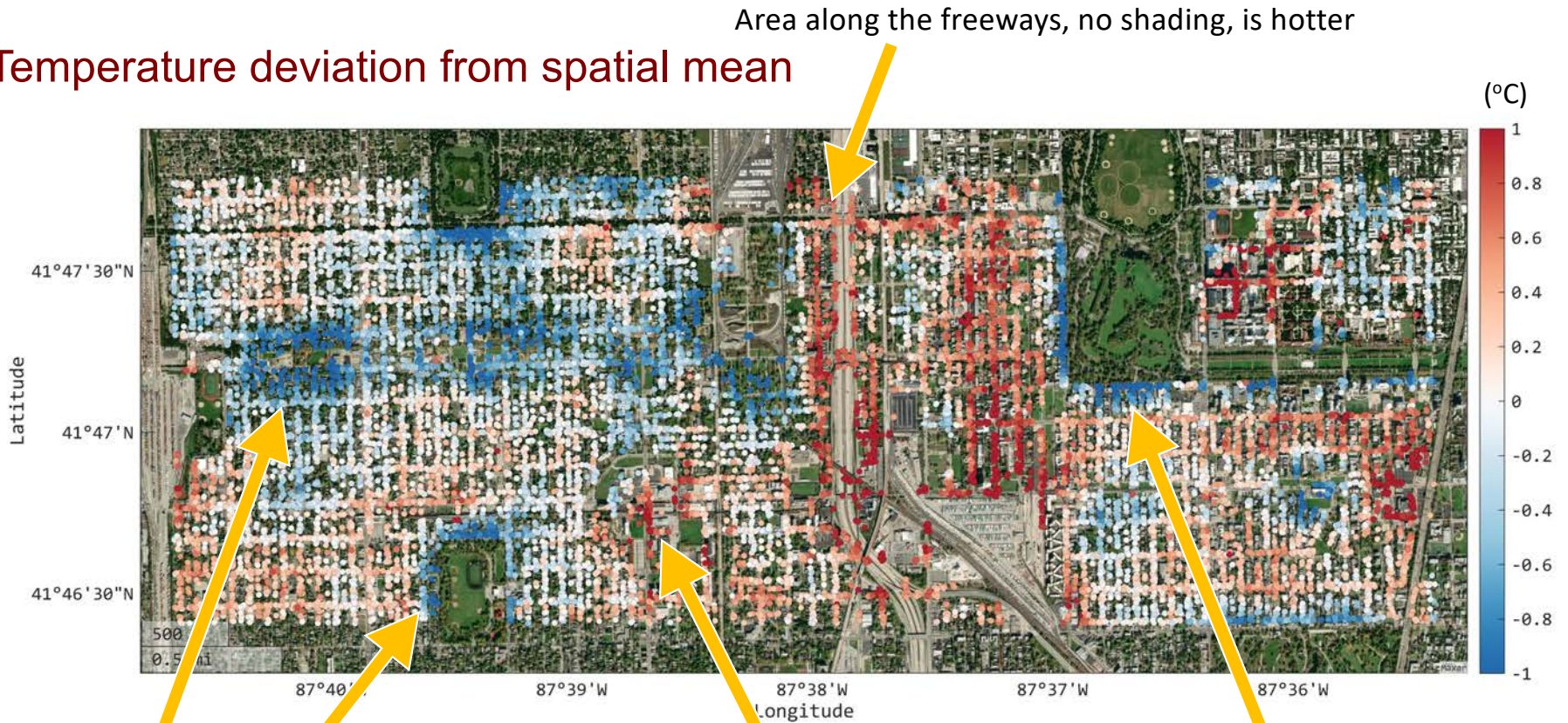
Street-level air temperature at resampled locations



- Downscale 1-km climate prediction to sub-meter street-level air temperature using machine learning.

# Address Urban Planning issues at street scales

## Temperature deviation from spatial mean



Li and Sharma (2024), JAMES

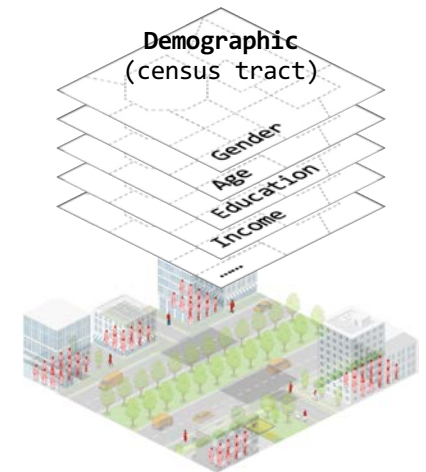
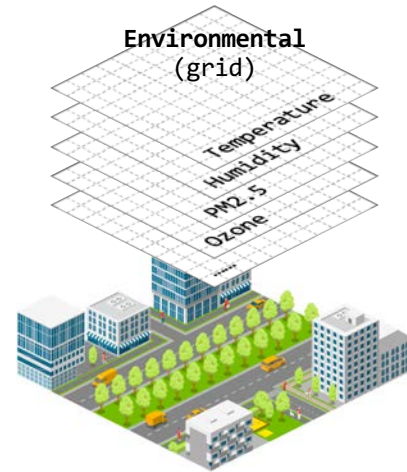
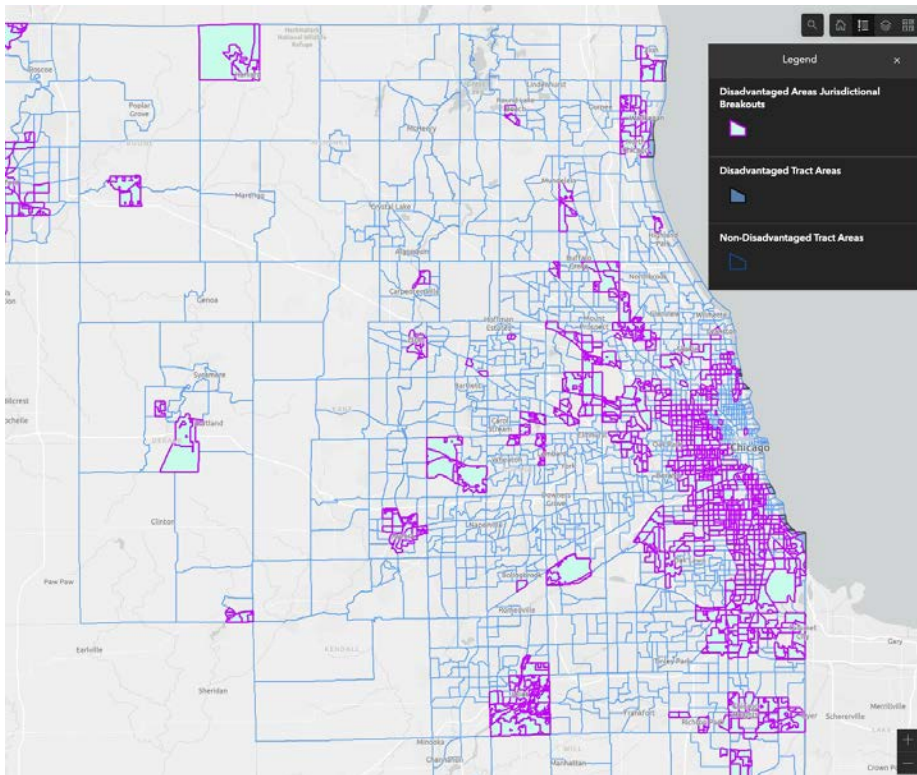


# Nomenclature of Environmental Justice

- **Environmental Justice** -- The just treatment and meaningful involvement of all people - regardless of race, color, national origin, income, or ability - with respect to development, implementation, and evaluation of programs, practices, and activities that affect human health and the environment.
- **Underserved Communities**: populations sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life.
- **EJ Communities**: Geographic locations with significant representation of persons of color, low-income persons, indigenous persons or members of Tribal nations, where such persons experience, or are at risk of experiencing, higher or more adverse human health or environmental outcomes.

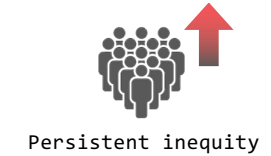
# Environmental justice conceptual framework

## Overburdened and Underserved Disadvantage Areas



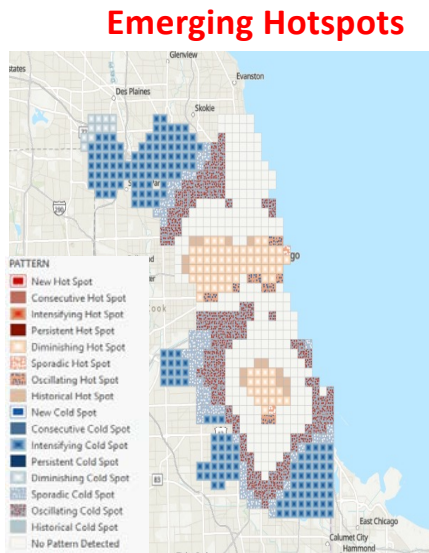
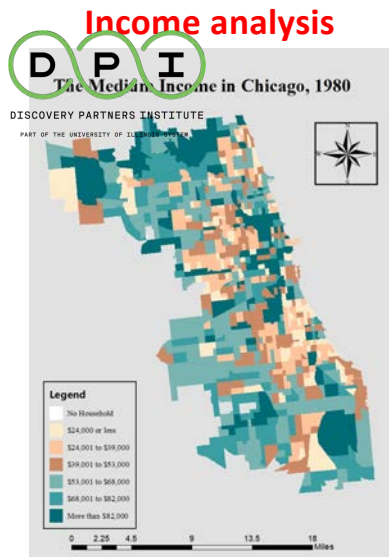
Climate change

Population growth



Sharma et al. (in prep)

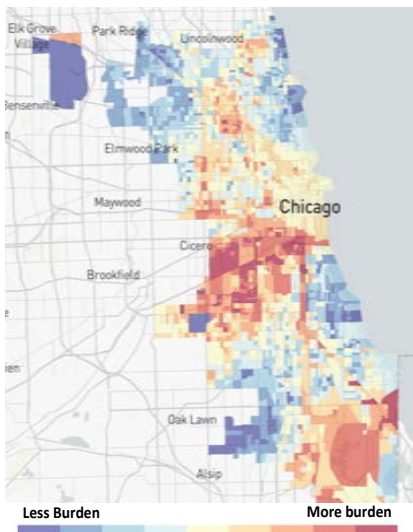
## Northeast Illinois Climate & Environmental Justice Dashboard



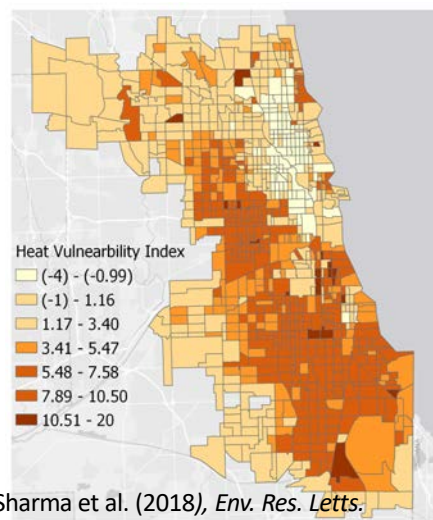
## Social and environmental stresses

- Chicago 8<sup>th</sup> in income inequality among the nation's largest cities.

### Air quality and health burden



### Heat Vulnerability Index

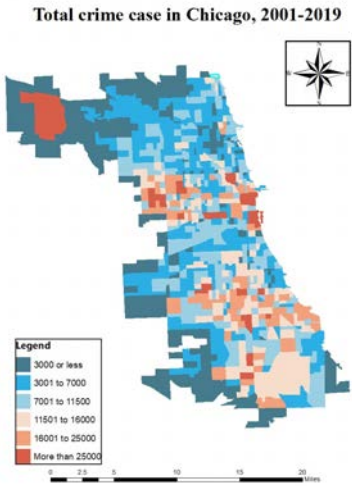


- 'Healthy' level of inequality is needed to encourage growth and progress.

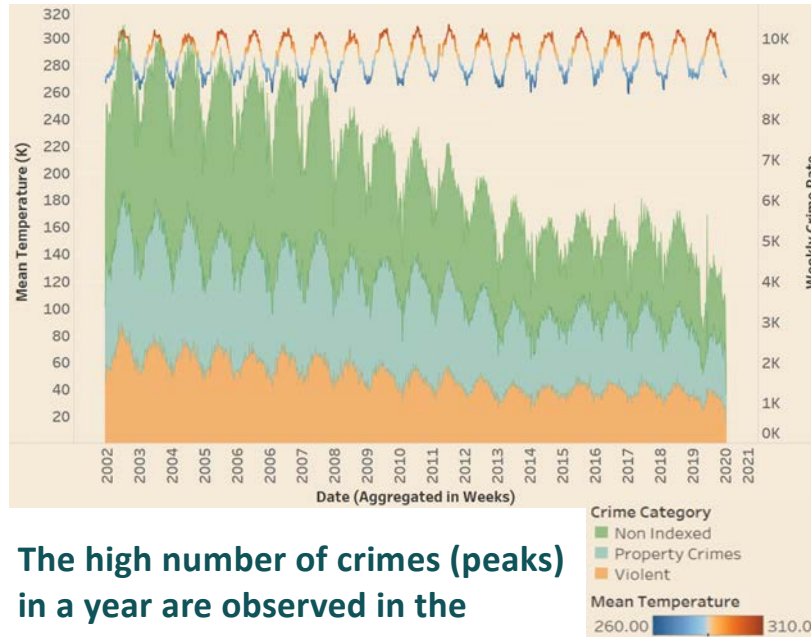
**But how much inequality is too much?**

# Crime and temperatures

## Total Crime (2001-2019)

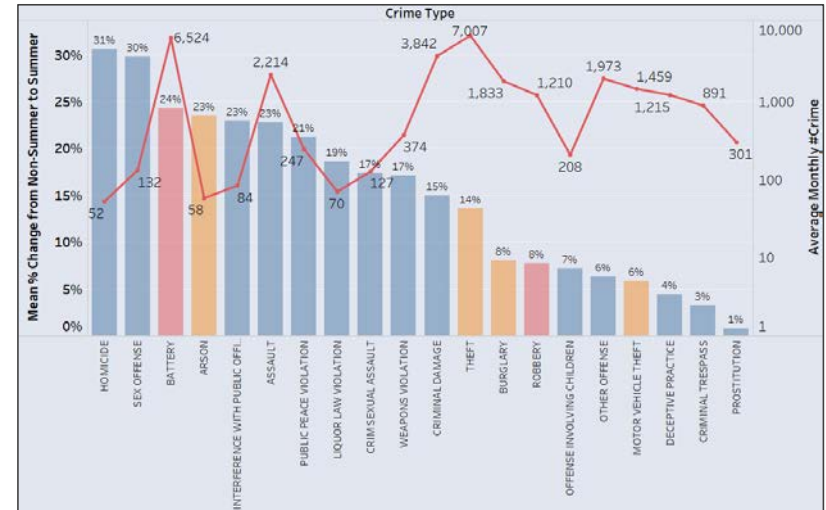


## Weekly Crime Rate vs Temperature



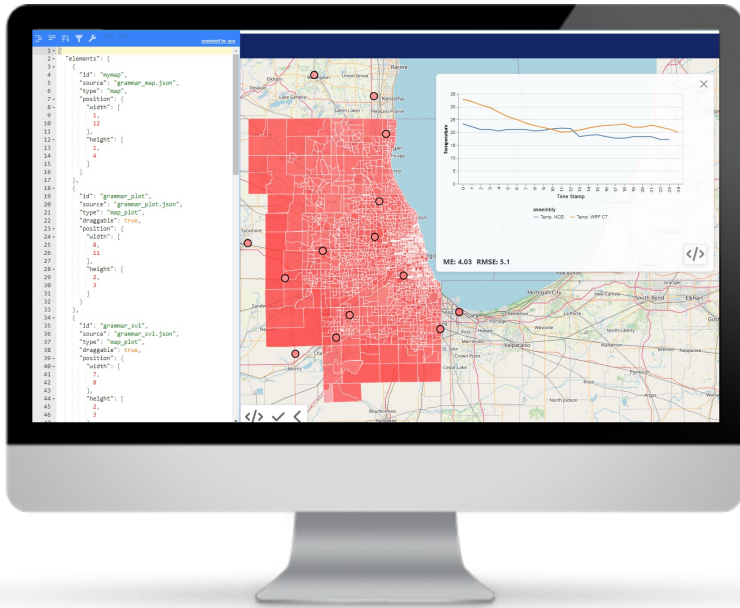
The high number of crimes (peaks) in a year are observed in the summer months whilst the low number (valleys) in a year are in winter months

## Seasonal Change in Average Crime Rate by Type



The average monthly number of Battery incidents reported increased in summer by 24% wrt non-summer months to 6,524 average number of incidents

# Visualization tools



Policymakers and staff



Interdisciplinary scientists  
and researchers



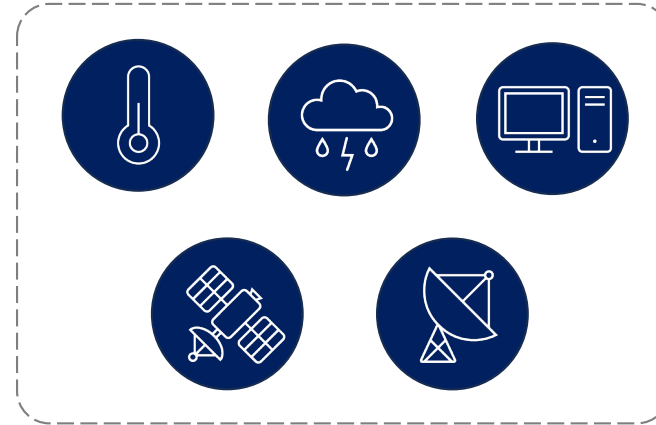
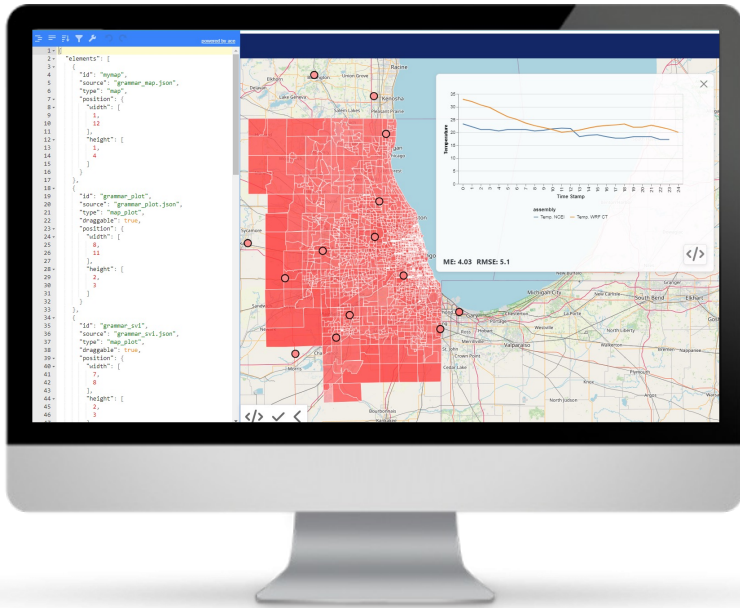
Developers



Community Members



# Visualization tools

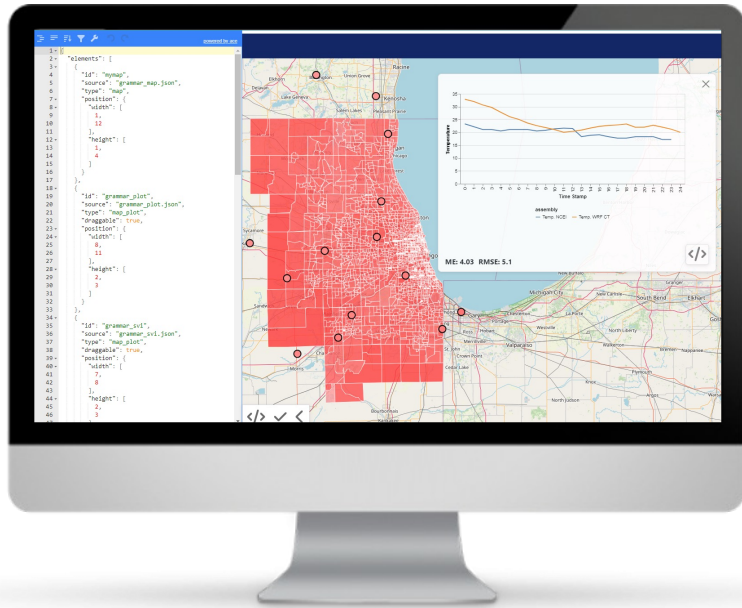


Weather and Climate Data



Demographic Data

# Visualization tools

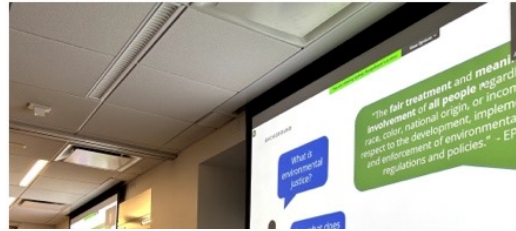


adaptable system to meet new demands without requiring a complete rebuild; new functionalities



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# Meetings with the community



# e-JUST

## Environmental Justice using Urban Scalable Toolkit

Flexibility

Extensibility

Reproducibility

Portability

Scalability

Accessibility



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```

1 #include "UrbaneMapView.hpp"
2
3 #include <QApplication>
4 #include "../MapView/BuildingRenderingLayer.hpp"
5
6 #include "../MassingGeneration/massinggeneration.h"
7 #include "../Util/ColorMapDivergent.hpp"
8 #include "UrbaneManager.hpp"
9
10 #include <QElapsedTimer>
11 #include <QThread>
12 #include <QDir>
13
14 #include <vector>
15
16 UrbaneMapView::UrbaneMapView(const QString &filename, const QRectF &vp, QWidget *parent)
17     : MapView(filename, vp, parent), graphLayer(NULL)
18 {
19     initialized = false;
20     skyExposureData = false;
21     this->centerIndex = GridIndex(1024, 1024);
22     this->currentLayer = NULL;
23     this->lotUpdate = true;
24 }
25
26 UrbaneMapView::~UrbaneMapView() {}
27
28 void UrbaneMapView::initializeGL() {
29     if(!initialized) {
30         MapView::initializeGL();
31         this->buildingScore.initComputeShader();
32         this->skyScore.initComputeShader();
33     }
34     initialized = true;
35 }
36
37 void UrbaneMapView::paintGL()
38 {
39     this->showOsd(false);
40
41     // Lot data initialization in manager
42     // TODO Don't know of a better place to do this
43     if(lotUpdate && this->parcelLayer->isDataReady()) {
44         updateLotDataDB();
45         lotUpdate = false;
46     }
47
48     UrbaneManager *manager = UrbaneManager::getInstance();
49     QPair<RenderingOperation, UIOperation> state = manager->getState();
50
51     RenderingOperation operation = state.first;
52     UIOperation what = state.second;
53     switch(operation) {
54     case RenderingOperation::UpdateVis:
55     {
56         bool updateFunction = false;

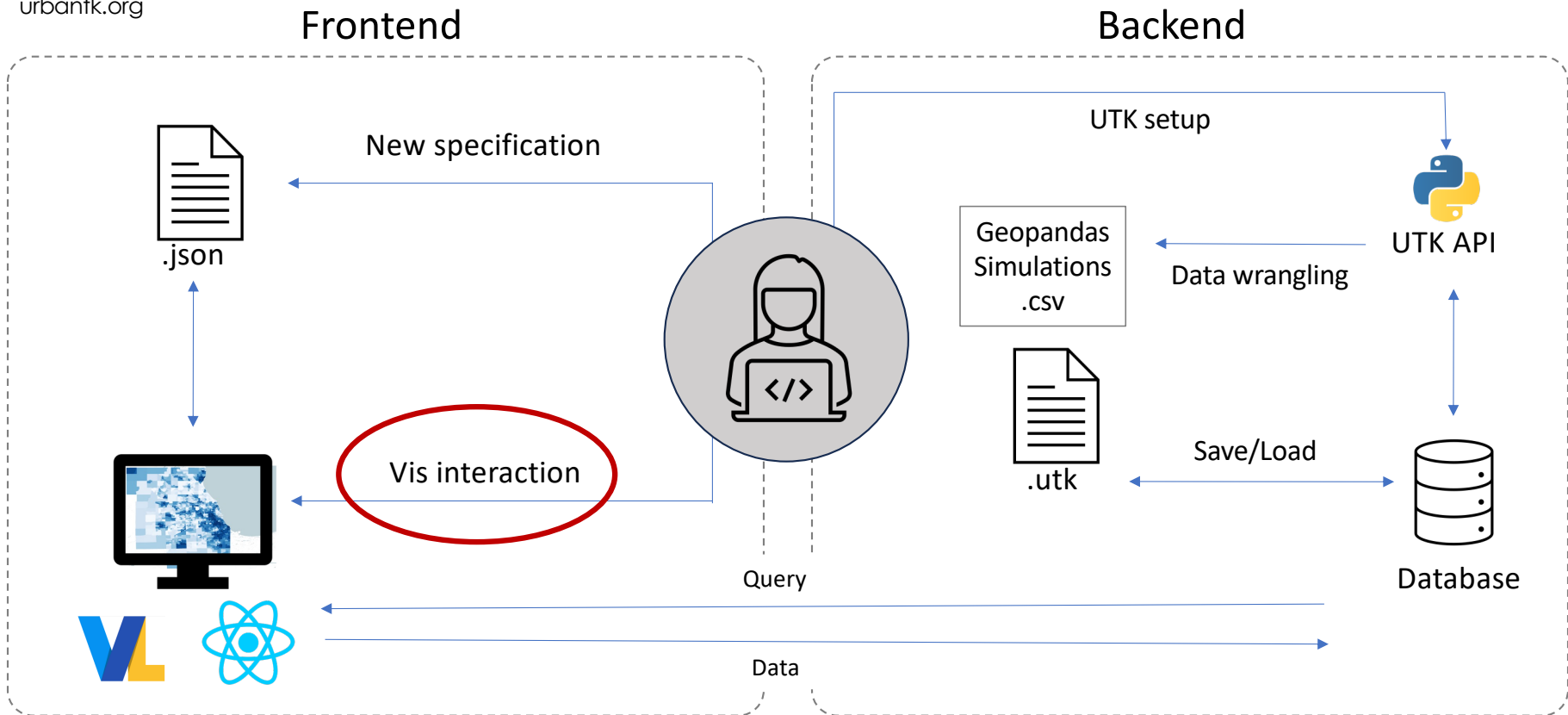
```

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9                     "lookAt": [962.3882446289062, 351.6265563964844, -134.21630859375],
10                    "up": [0.012851359322667122, 0.6320154070854187, 0.7748492360115051]
11                }
12            },
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14            "interactions": ["NONE", "NONE", "NONE", "NONE"]
15        },
16        "plots": [
17            {
18                "plot": {
19                    "mark": "bar",
20                    "encoding": {
21                        "x": {"bin": true, "field": "shadowToBuildings_abstract"},
22                        "y": {"aggregate": "count"}
23                    }
24                },
25                "knots": ["shadowToBuildings"],
26                "arrangement": "LINKED"
27            }
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35                    }
36                ]
37            },
38            {
39                "id": "purewater",
40                "integration_scheme": [
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42                        "out": {"name": "water", "level": "OBJECTS"}
43                    }
44                ]
45            },
46            {
47                "id": "pureroads",
48                "integration_scheme": [
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51                    }
52                ]
53            },
54            {
55                "id": "shadowToBuildings",
56                "integration_scheme": [

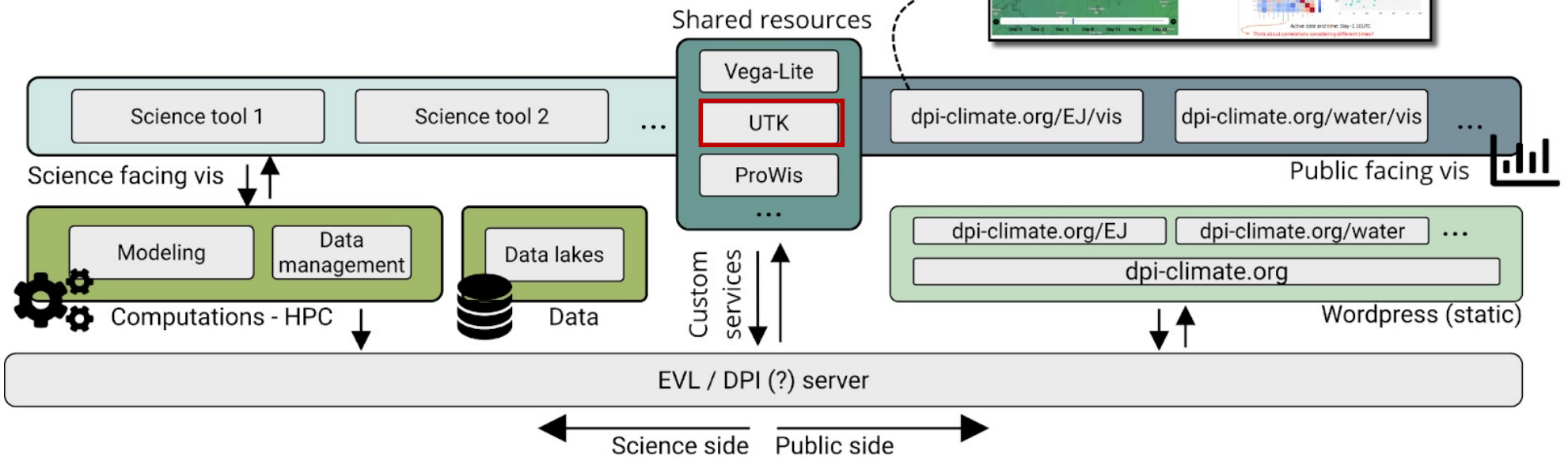
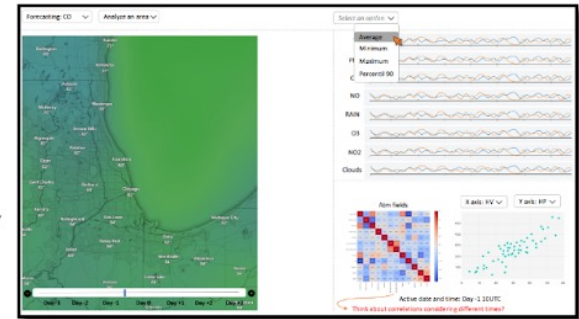
```

# Architecture



Handle data from satellites, models, observations

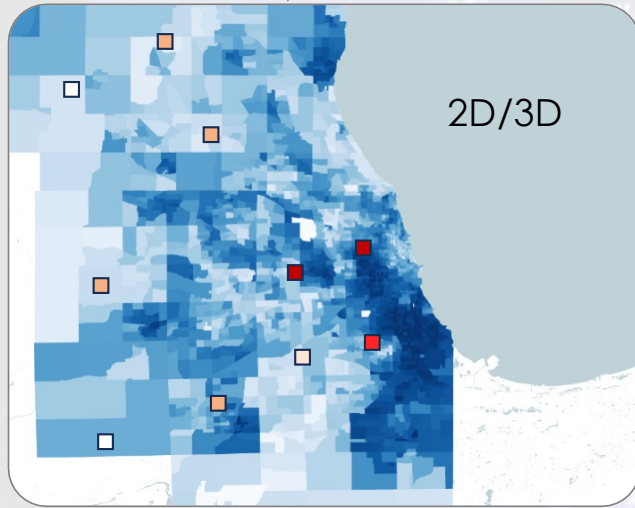
Both science facing and public facing visualizations



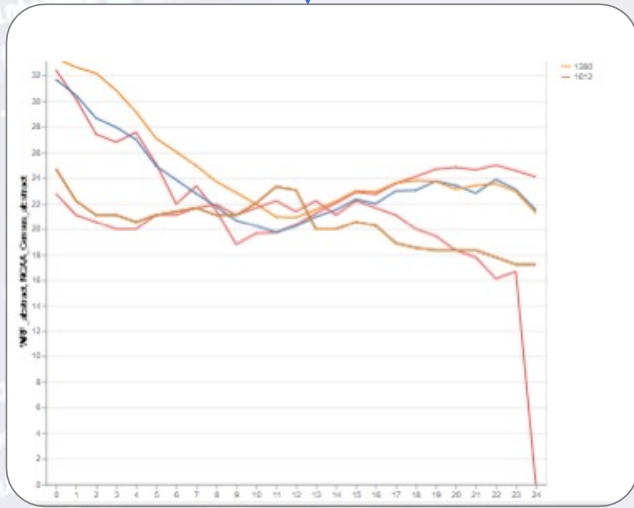
```
3 require File.expand_path
4 # Prevent database truncation
5 abort("The Rails environment is running in production mode!")
6 require 'spec_helper'
7 require 'rspec/rails'
8
9 require 'capybara/rspec'
10 require 'capybara/rspec'
11
12 Capybara.javascript = true
13 Category.create(:name => 'Category 1')
14 Shoulda::Matchers.configure do |config|
15   config.integrate do |s|
16     s.add_matcher :have_attributes
17   end
18 end
```

```
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  "components": [
    {
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      "position": {
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          4
        ]
      }
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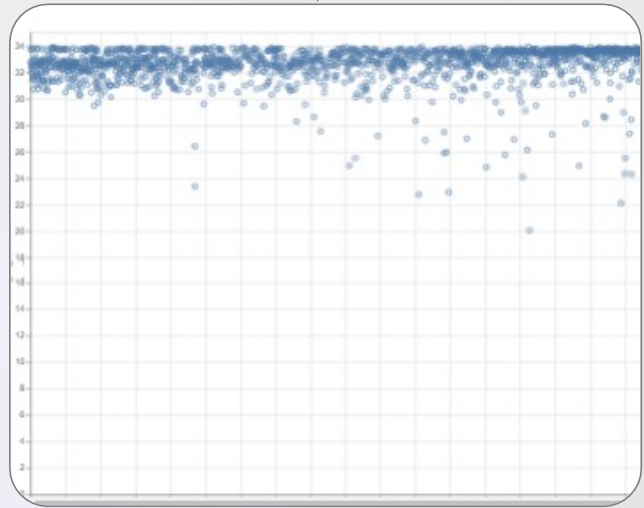
JSON



**Spatial Exploration**



**Temporal Overview**

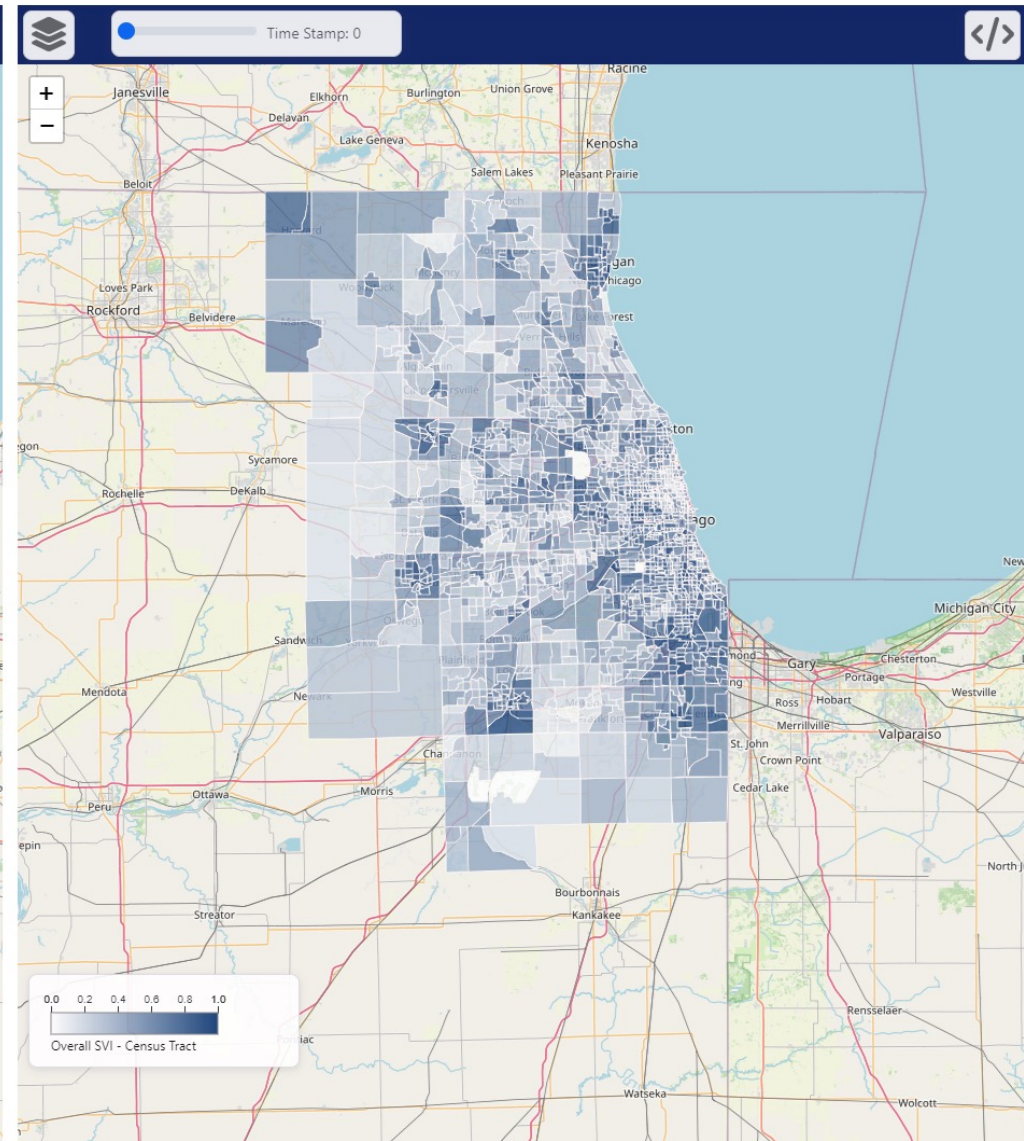
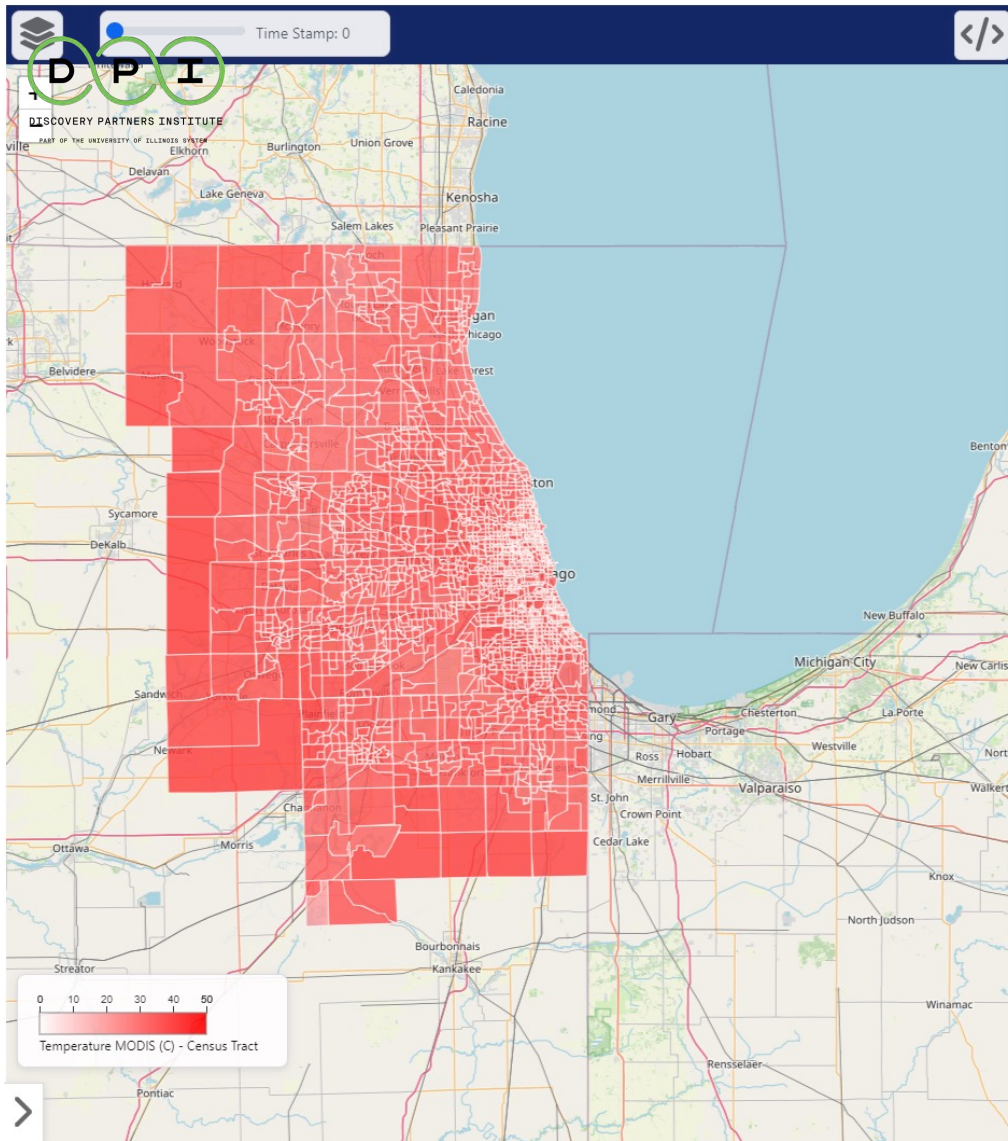


**Analytics**

Veiga et al., (in prep)

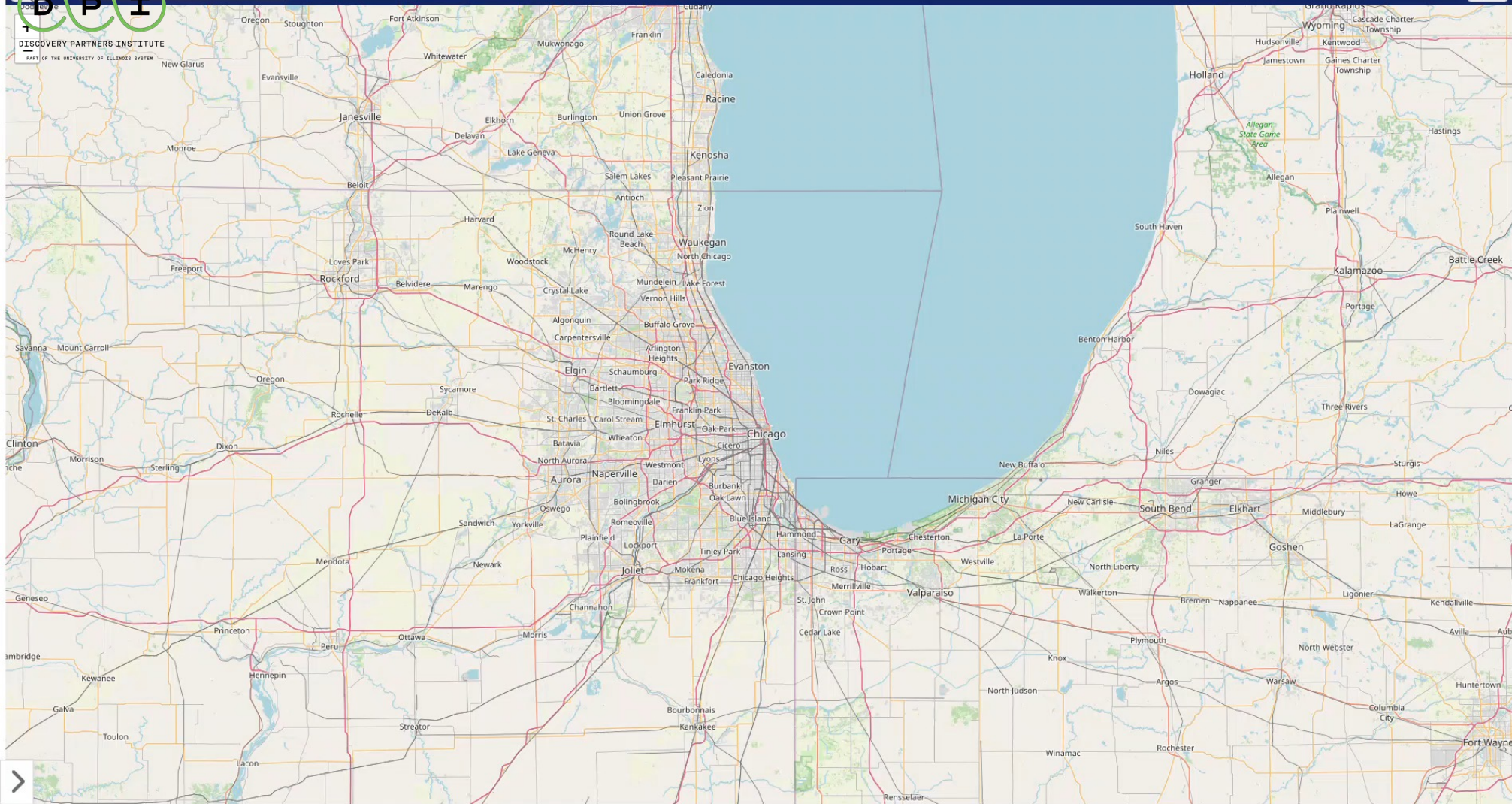


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10-          12
11-        ],
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14-         4
15-       ]
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29-           3
30-         ]
31-       }
32-     },
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41-           8
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44-           2,
45-           3
46-         ]
47-       }
48-     }
49-   ],
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51-     "width": 12,
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53-   },
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67-           4
68-         ]
69-       }
70-     },
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152-    }
153-  ],
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Time Stamp: 0



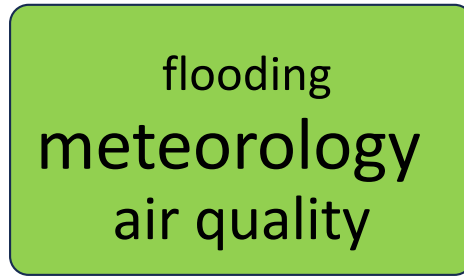
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text tree table [icons] [search] [refresh] [undo] [redo]
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8             5115001,
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10          ],
11         "direction": {
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14             -3128.7470703125,
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19             -598.5999755859375,
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21          ],
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23             0.016979672014713287,
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26          ]
27       }
28     }
29   ]
30 }
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Apply Grammar  Link

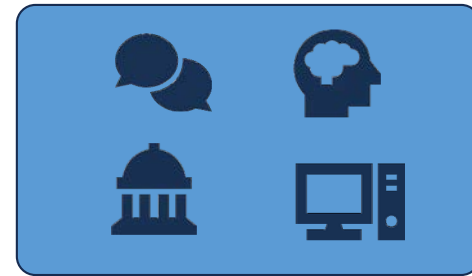
# Conclusions and Next Steps



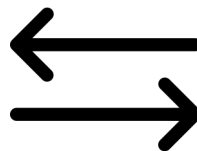
**Online + New Data**



**Models + Satellites**



**Story maps**





Thank you

Ashish Sharma

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