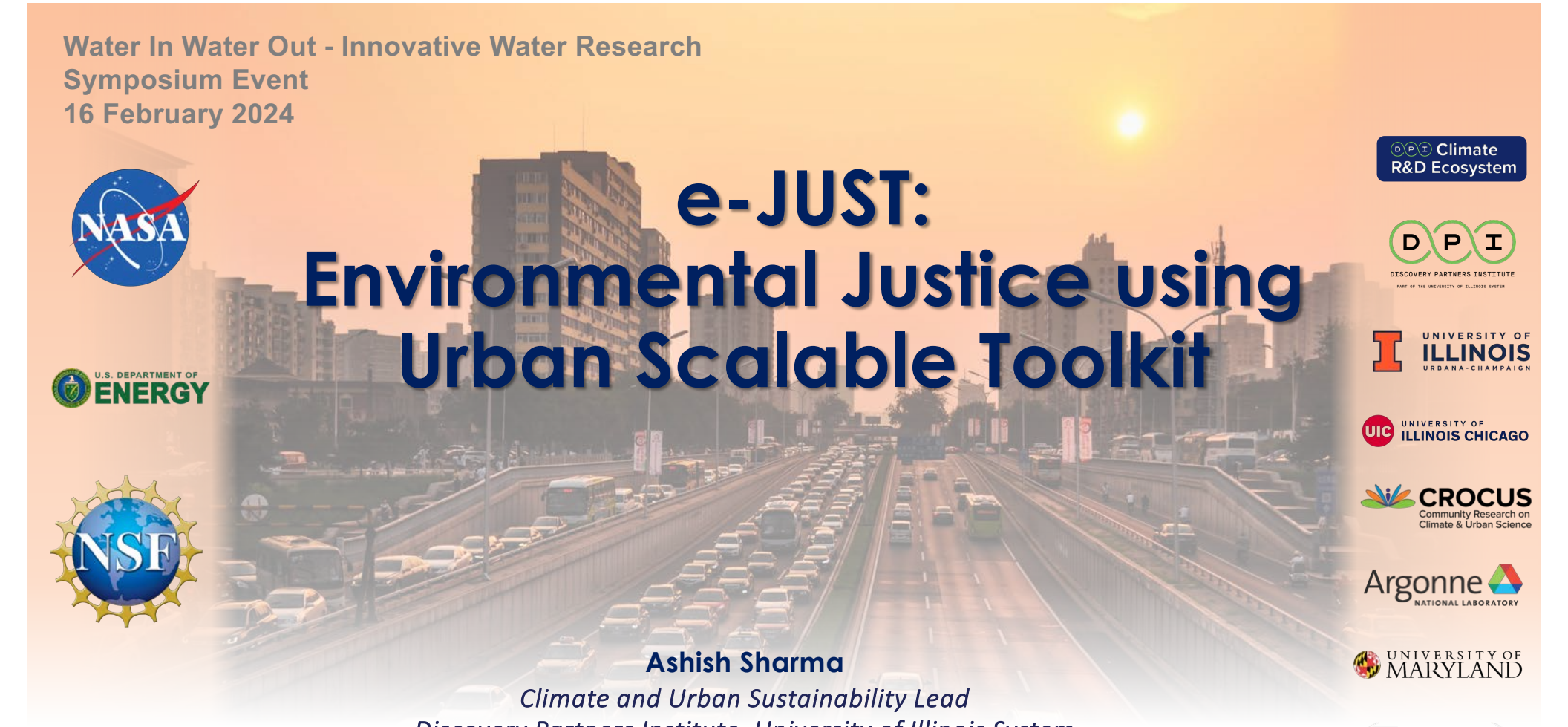
Water In Water Out - Innovative Water Research Symposium Event
16 February 2024

e-JUST: Environmental Justice using Urban Scalable Toolkit



Ashish Sharma

Climate and Urban Sustainability Lead

Discovery Partners Institute, University of Illinois System

Climate Scientist, Argonne National Laboratory

Email: sharmaa@illinois.edu

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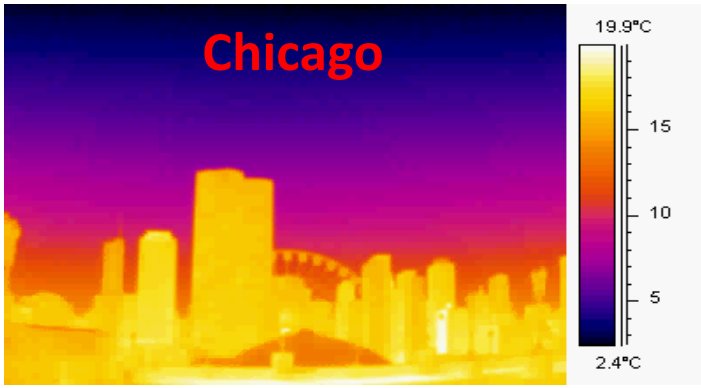
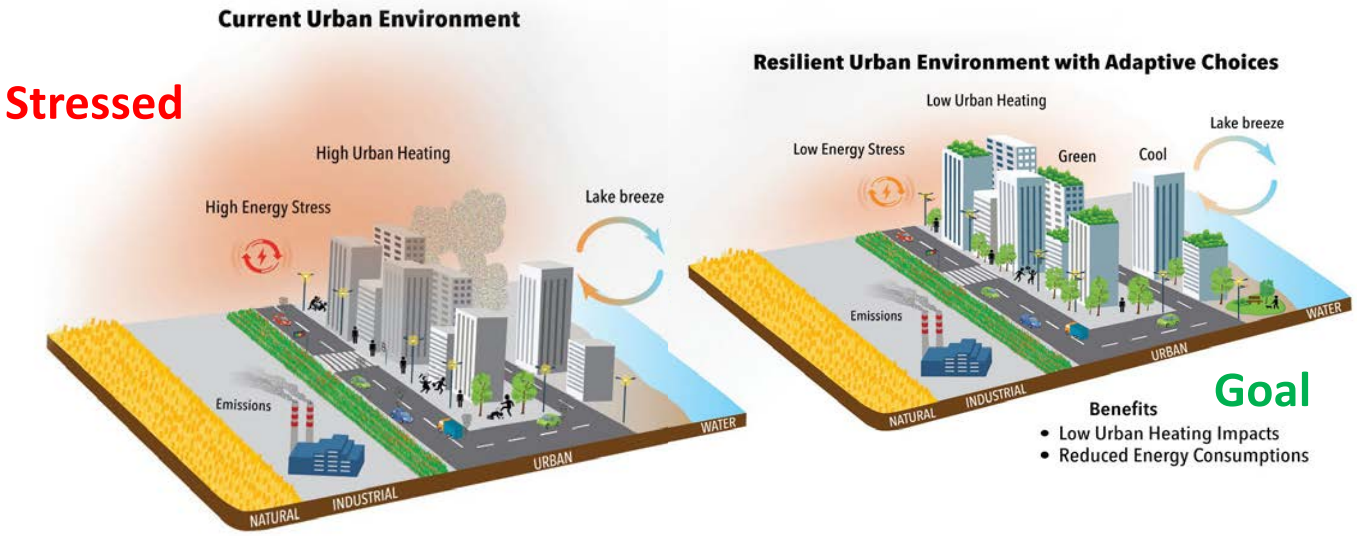
PART OF THE UNIVERSITY OF ILLINOIS SYSTEM

Urban systems

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





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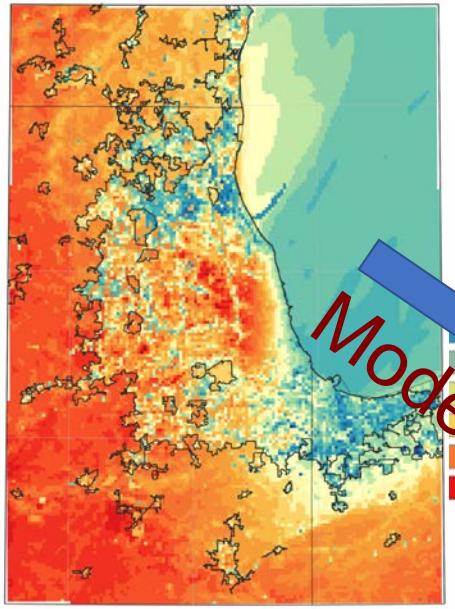
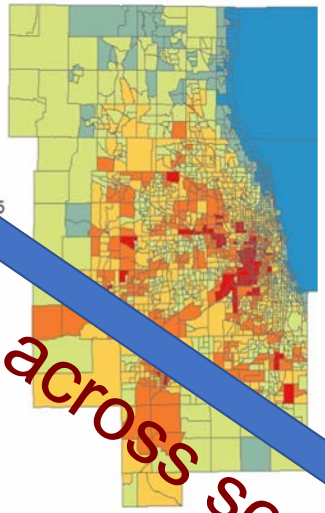
Computer (climate) urban models

Regional-scale models

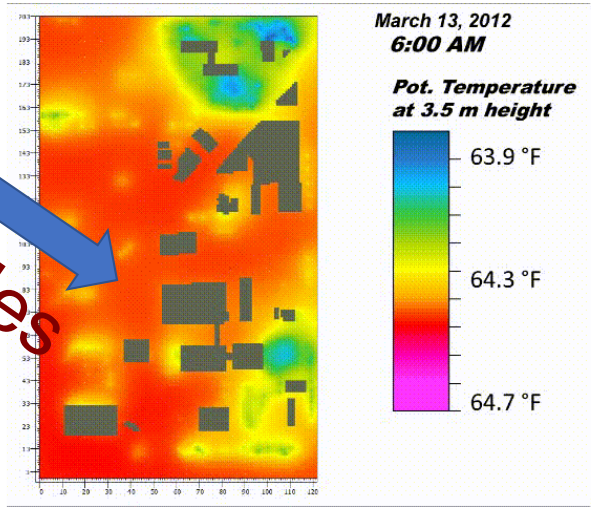


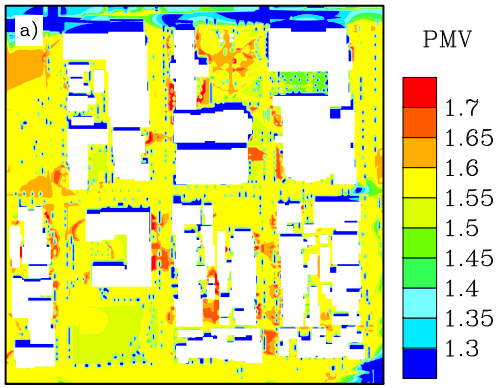
City-scale models



Models across scales

Neighborhood models (2 m resolution)





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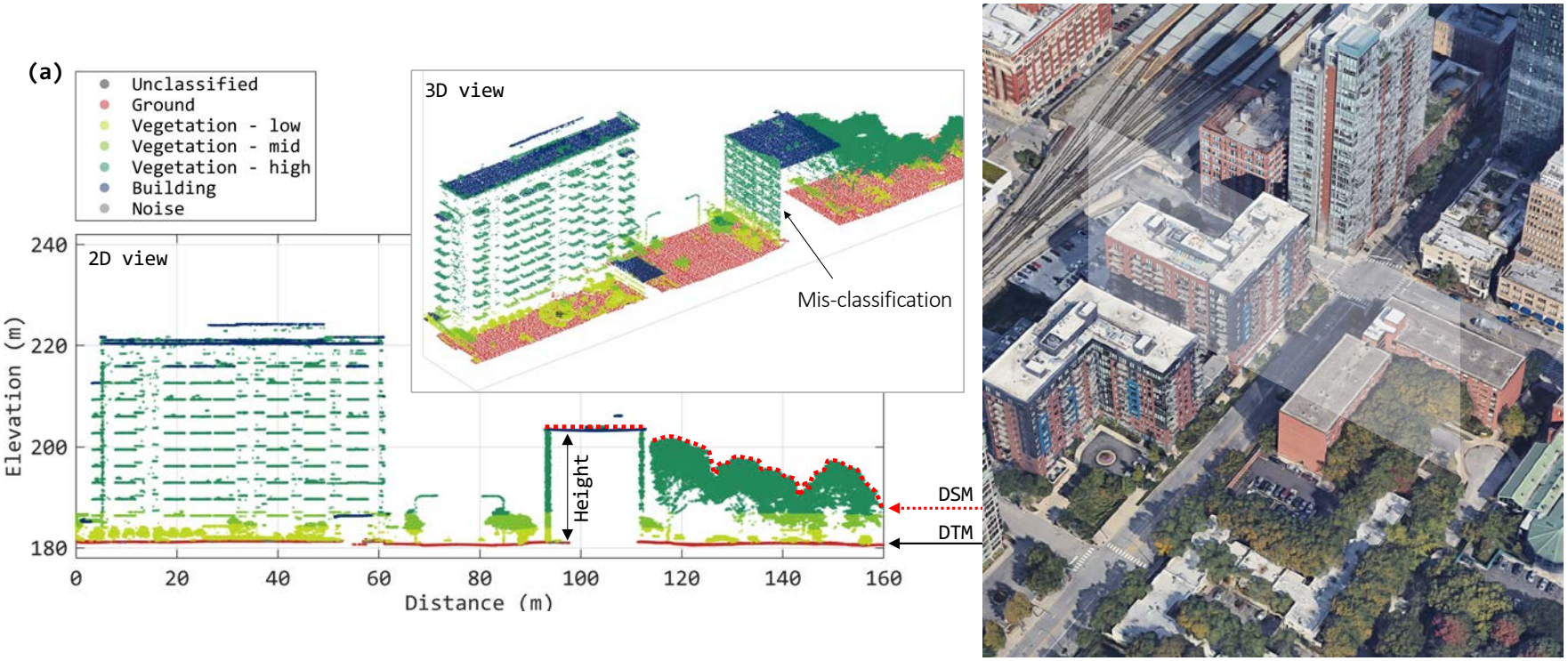
- LiDAR data at an exemplary street block

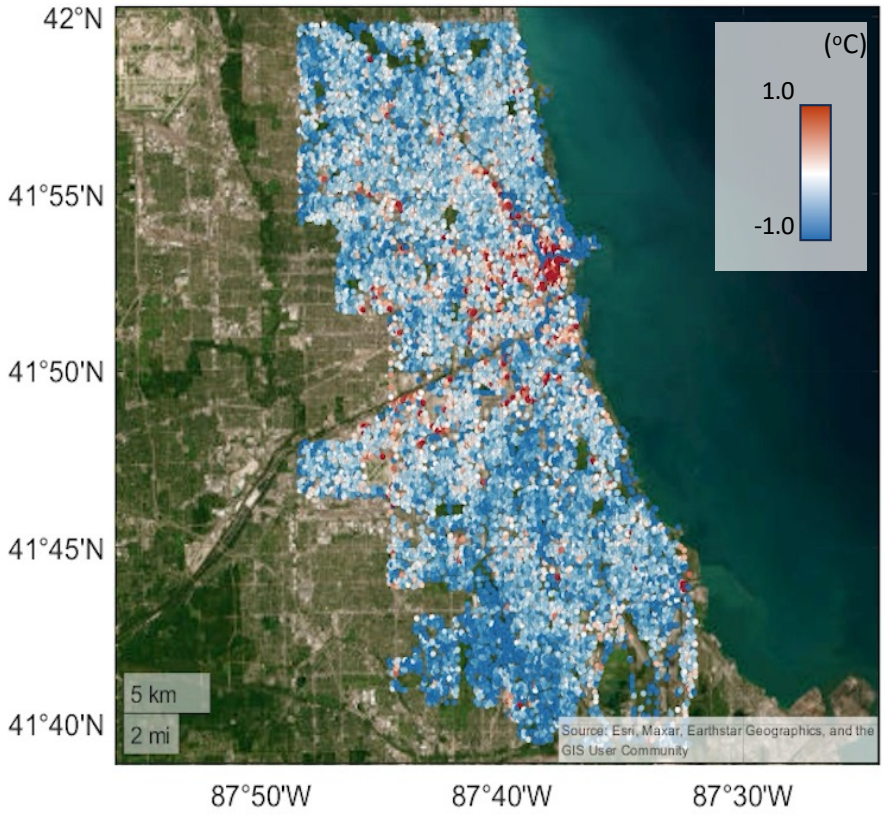


Li and Sharma (in prep)

Solutions at scales it matters

LiDAR point cloud dataset (ILHMP, 2018)

Temperature deviation from areal mean (hourly)



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

Li and Sharma (in prep)

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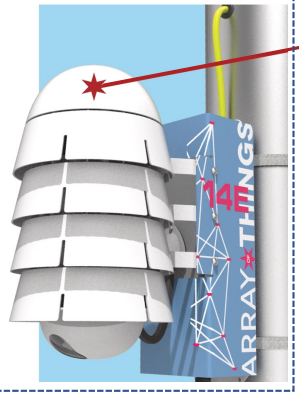
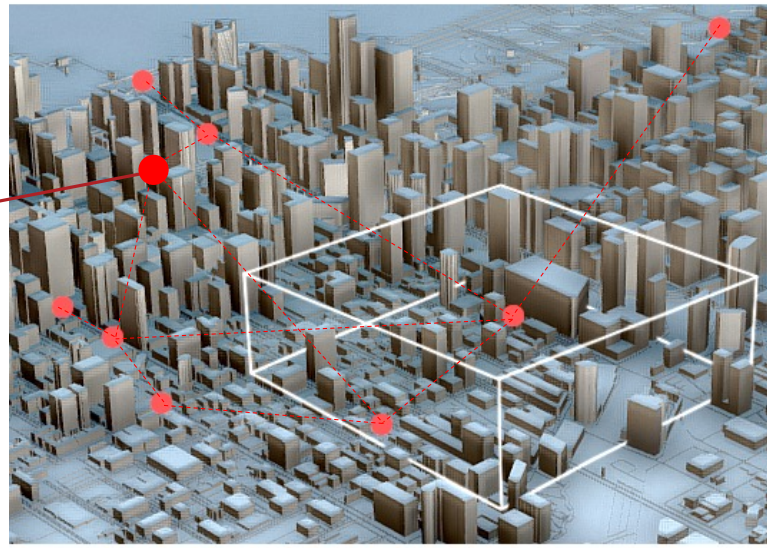
Urban informatics

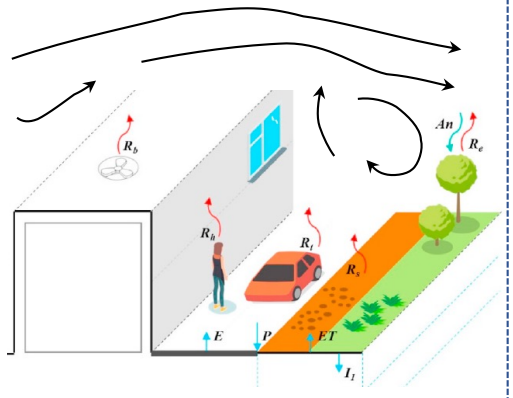
Street-level observation network



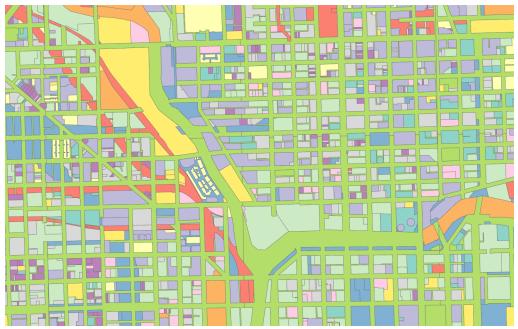


Urban Weather Forecast

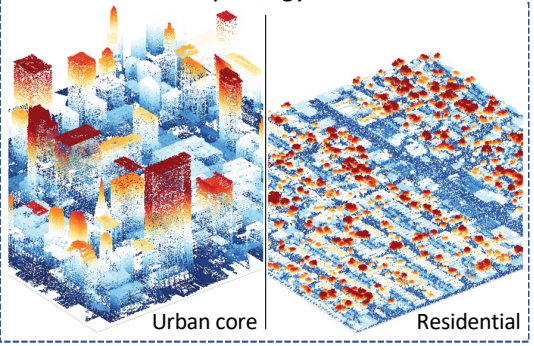
WRF/urban modeling framework



Parcel-level land use inventory

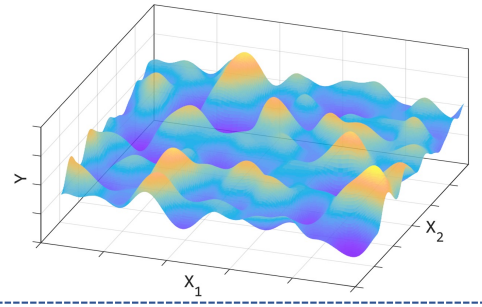


LiDAR urban morphology



Machine Learning

Gaussian Process Regression



Li and Sharma (in press); JAMES

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

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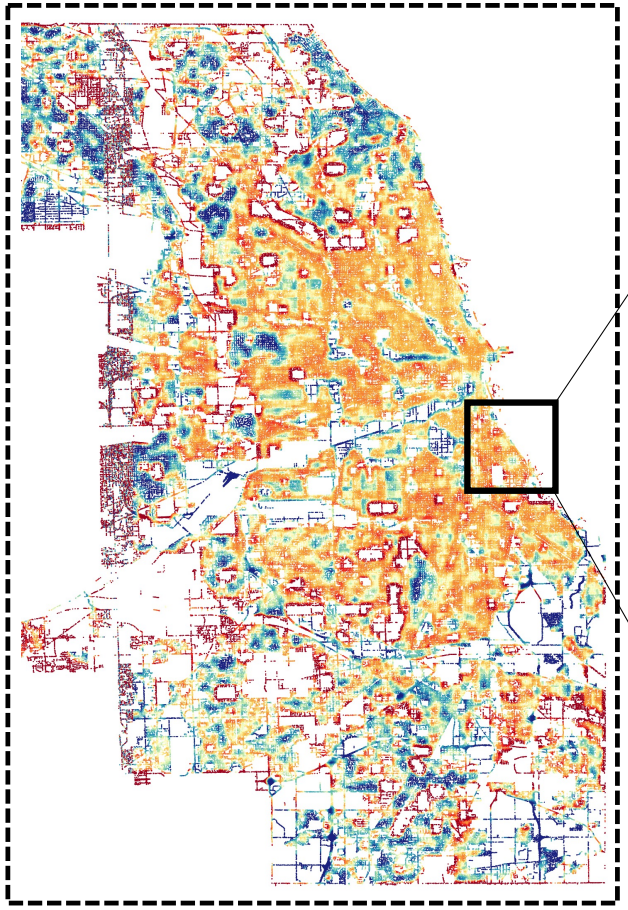
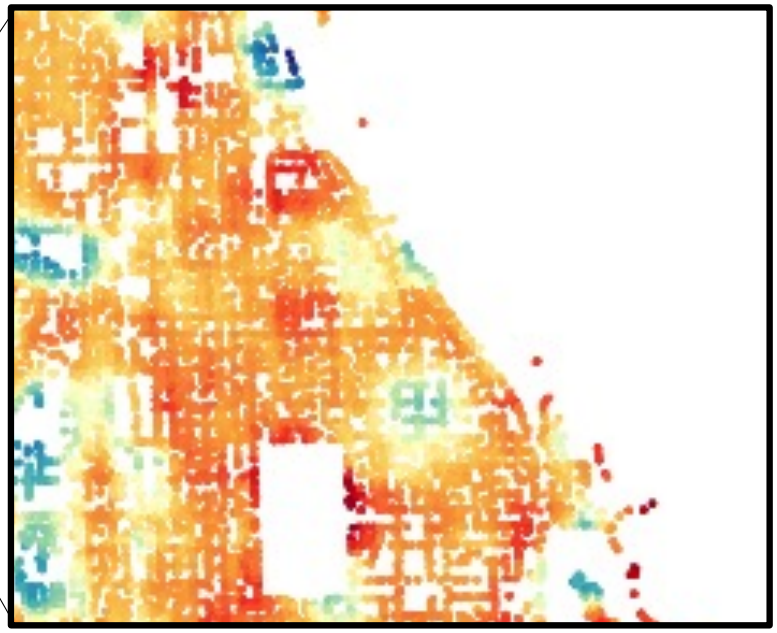
Street-level temperature estimation



Li and Sharma (in press)

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

Area along the freeways, no shading, is hotter

Temperature deviation from spatial mean

Area with dense vegetation is cooler.

Commercial corners are hotter

Li and Sharma (in press); JAMES

Street near large urban parks is cooler

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Nomenclature of Environmental Justice

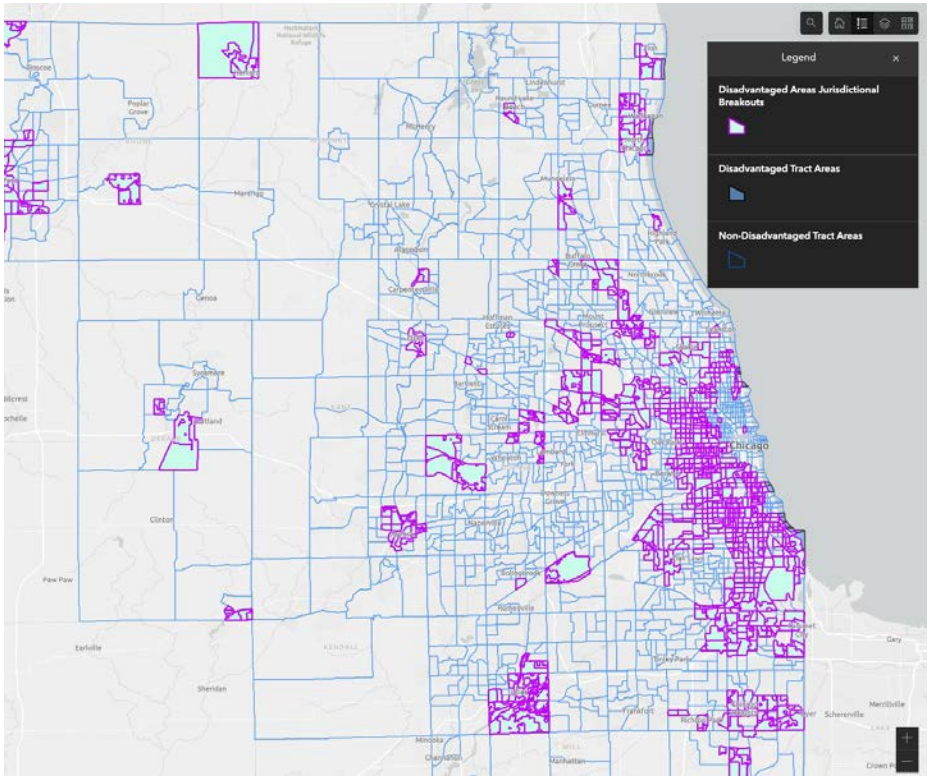
- **Environmental Justice** -- The just treatment and meaningful involvement of all people - regardless of race, color, national origin, income, or ability - with respect to development, implementation, and evaluation of programs, practices, and activities that affect human health and the environment.

- **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.

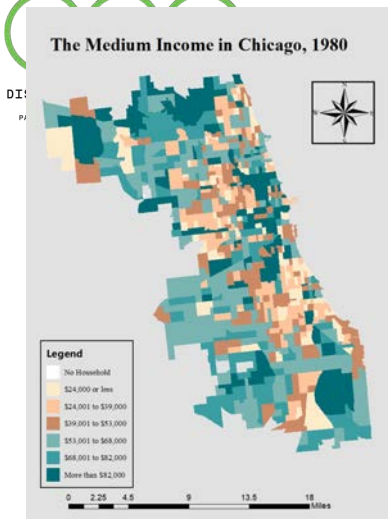
Environmental justice conceptual framework

Overburdened and Underserved Disadvantage Areas

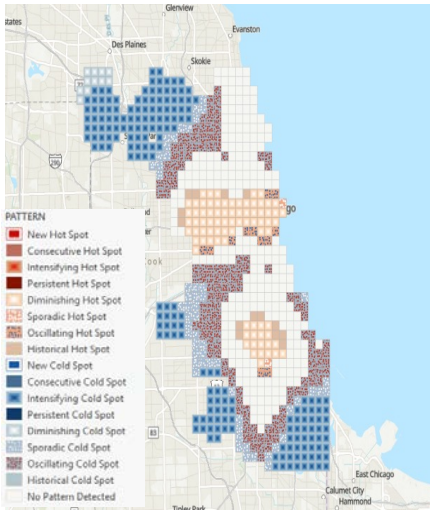


Northeast Illinois Climate & Environmental Justice Dashboard

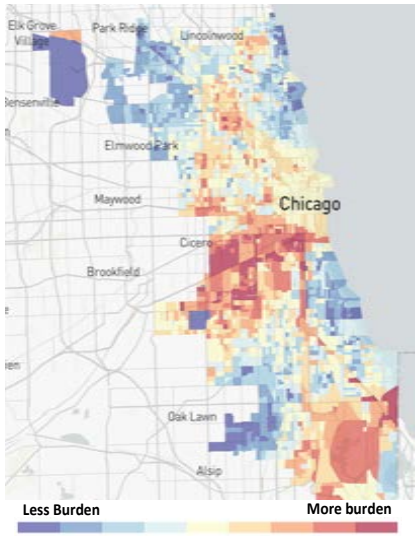
Income analysis



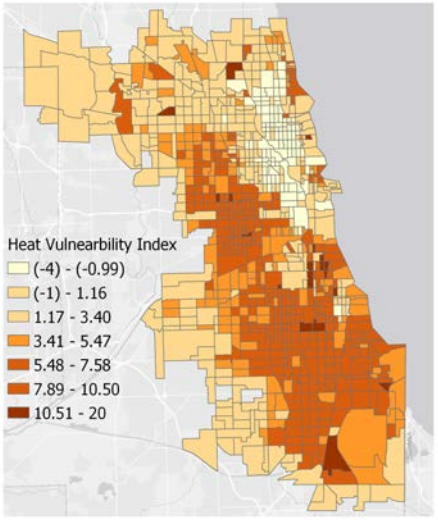
Emerging Hotspots



Air quality and health burden



Heat Vulnerability Index



Social and environmental stresses

- Chicago 8th in income inequality among the nation's largest cities.
- '**Healthy**' level of inequality is needed to encourage growth and progress.

But how much inequality is too much?

Crime and temperatures

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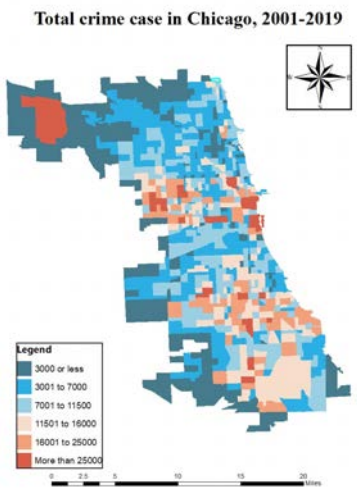
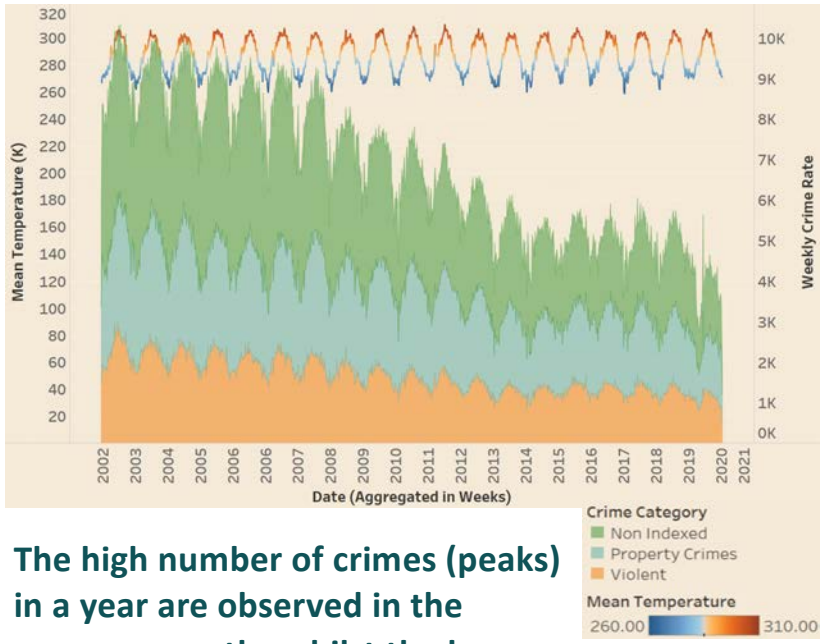
Total Crime (2001-2019)

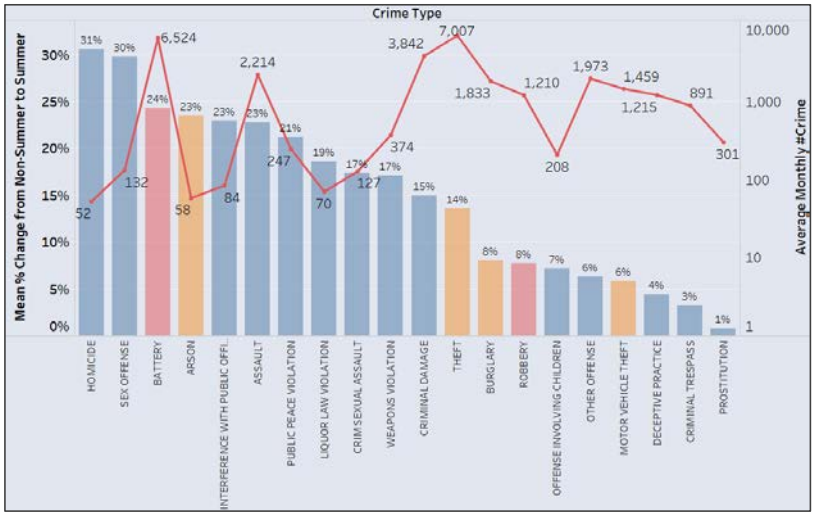


Weekly Crime Rate vs Temperature



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

(article in prep)

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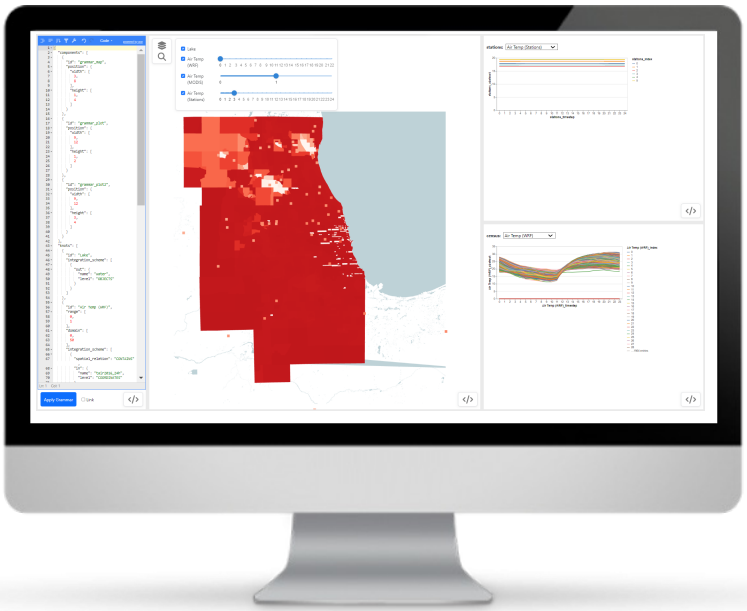
Visualization tools



Policymakers and staff

Interdisciplinary scientists and researchers

Developers

Community Members

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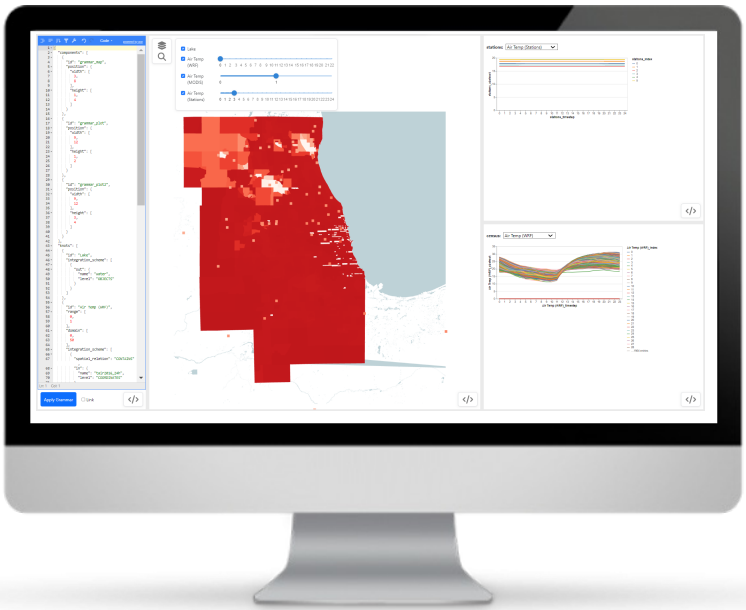
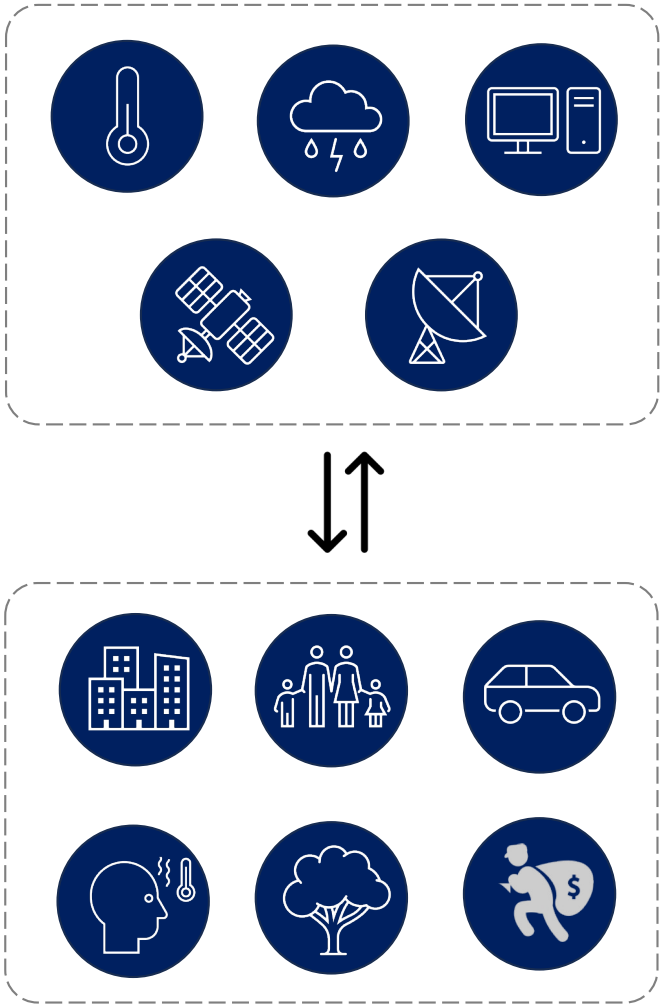
Visualization tools





Weather and Climate Data

Demographic Data

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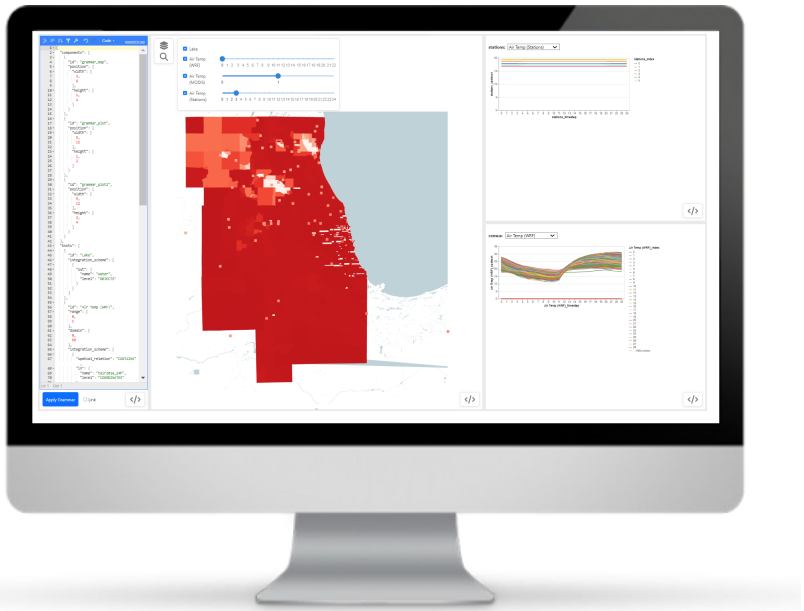
Visualization tools



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

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Meetings with the community

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e-JUST
Environmental Justice using Urban Scalable Toolkit

Flexibility

Extensibility

Reproducibility

Portability

Scalability

Accessibility

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```
#include "UrbaneMapView.hpp"

#include <QApplication>
#include "../MapView/BuildingRenderingLayer.hpp"

#include "../MassingGeneration/massinggeneration.h"
#include "../Util/ColorMapDivergent.hpp"
#include "UrbaneManager.hpp"

#include <QElapsedTimer>
#include <QThread>
#include <QDir>

#include <vector>

UrbaneMapView::UrbaneMapView(const QString &filename, const QRectF &vp, QWidget *parent)
    : MapView(filename,vp,parent), graphLayer(NULL)
{
    initialized = false;
    skyExposureData = false;
    this->centerIndex = GridIndex(1024,1024);
    this->currentLayer = NULL;
    this->lotUpdate = true;
}

UrbaneMapView::~UrbaneMapView() {}

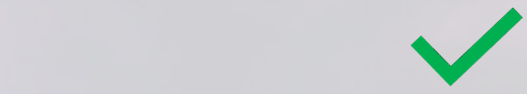
void UrbaneMapView::initializeGL() {
    if(!initialized) {
        MapView::initializeGL();
        this->buildingScore.initComputeShader();
        this->skyScore.initComputeShader();
    }
    initialized = true;
}

void UrbaneMapView::paintGL()
{
    this->showOsd(false);

    // Lot data initialization in manager
    // TODO Don't know of a better place to do this
    if(lotUpdate && this->parcelLayer->isDataReady()) {
        updateLotDataDB();
        lotUpdate = false;
    }

    UrbaneManager *manager = UrbaneManager::getInstance();
    QPair<RenderingOperation, UIOperation> state = manager->getState();

    RenderingOperation operation = state.first;
    UIOperation what = state.second;
    switch(operation) {
    case RenderingOperation::UpdateVis:
    {
        bool updateFunction = false;
```



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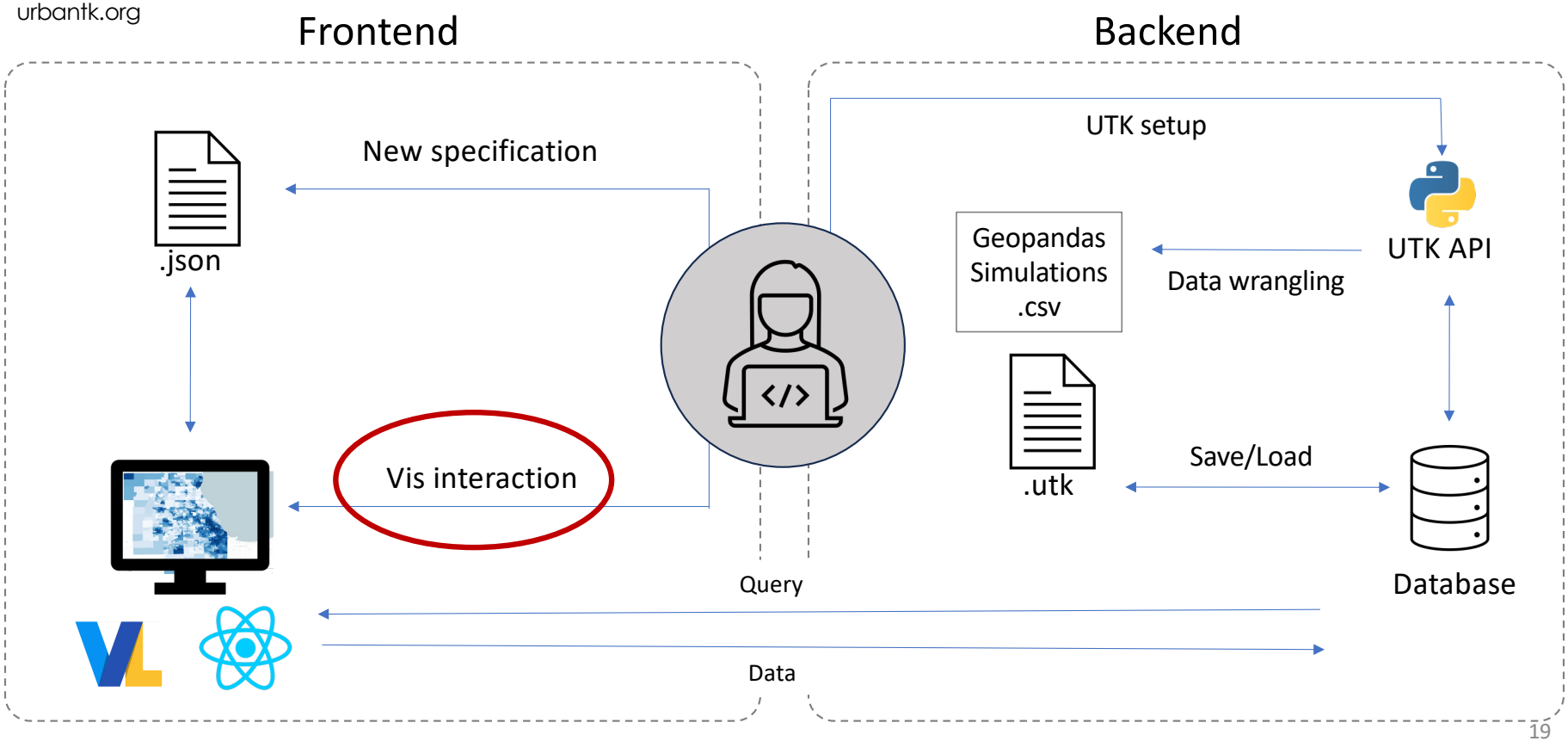
```

Architecture

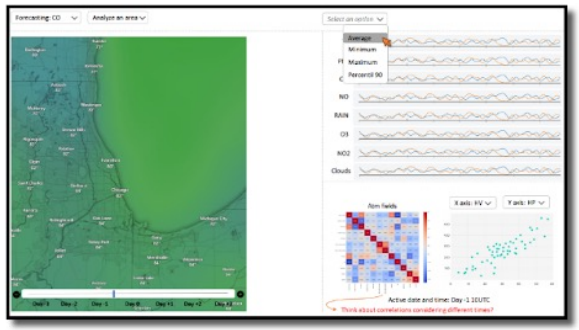
Moreira et al. 2023
urbantk.org

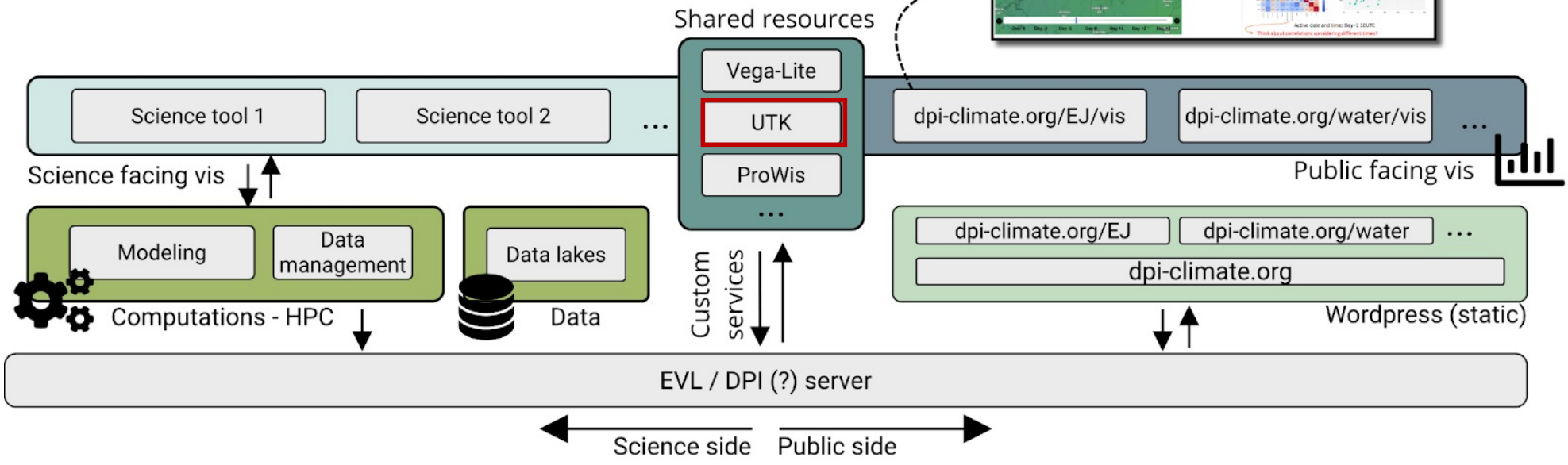


e-JUST

Handle data from satellites, models, observations

Both science facing and public facing visualizations





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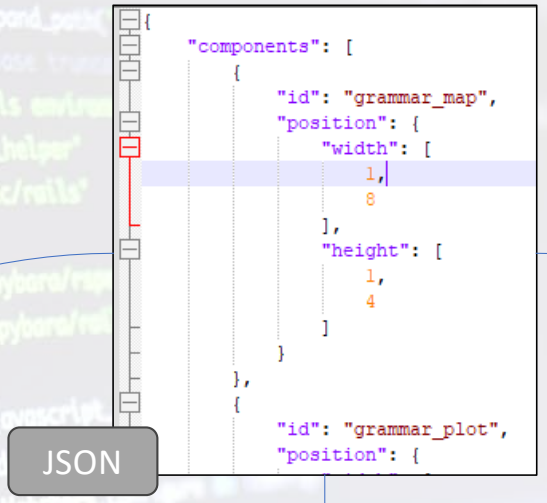
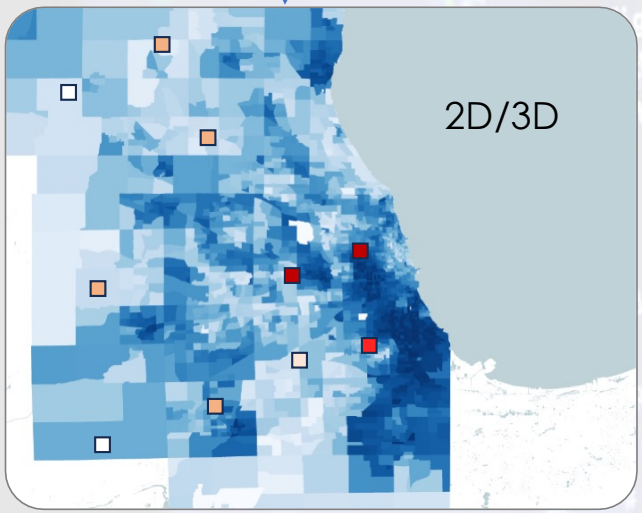
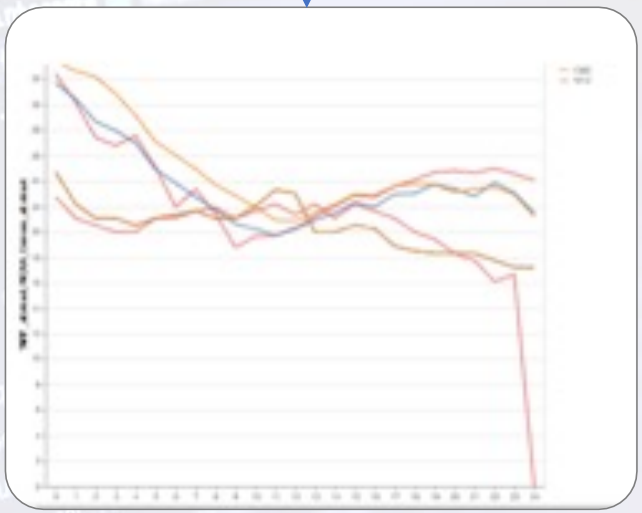
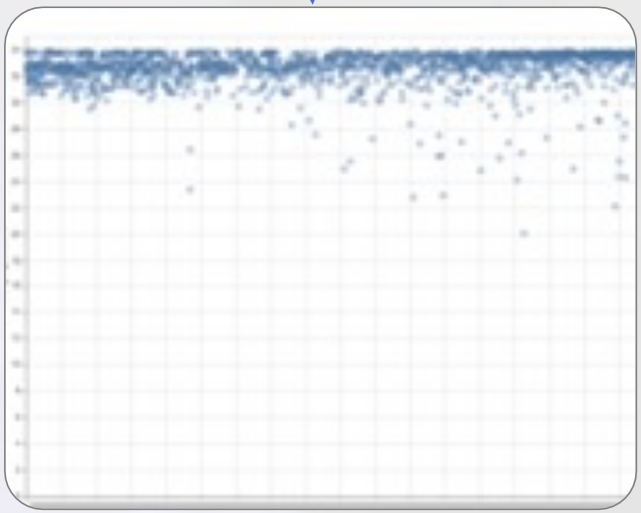




Spatial Exploration



Temporal Overview



Analytics

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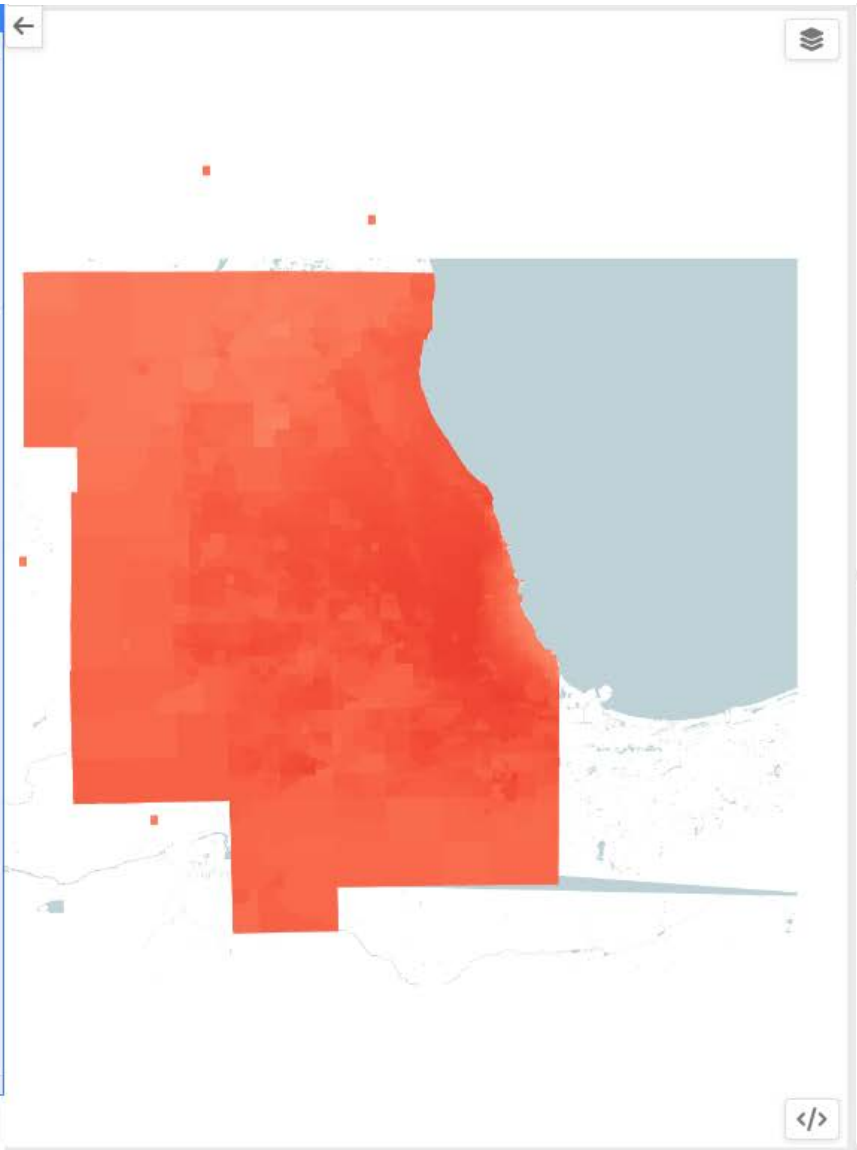

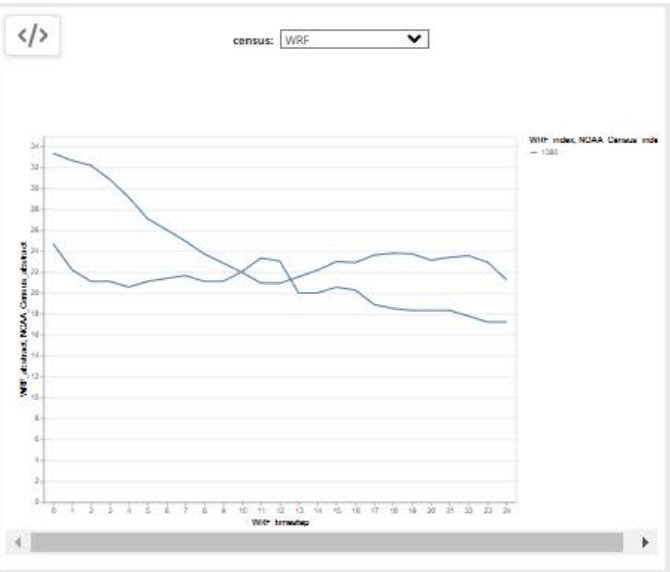

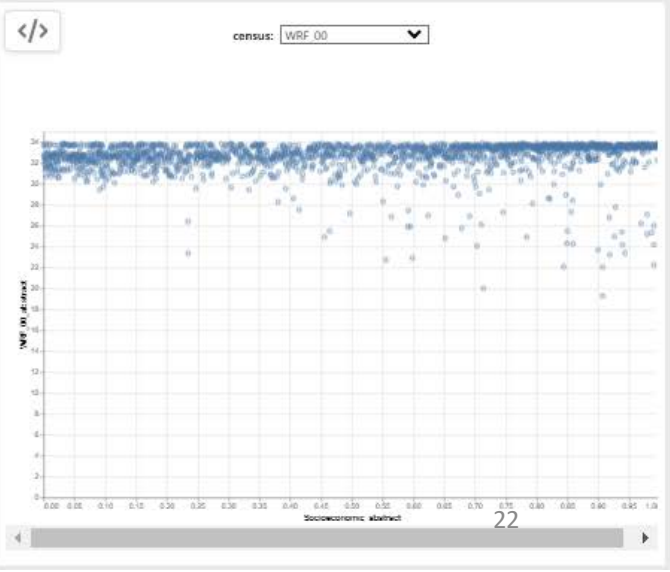

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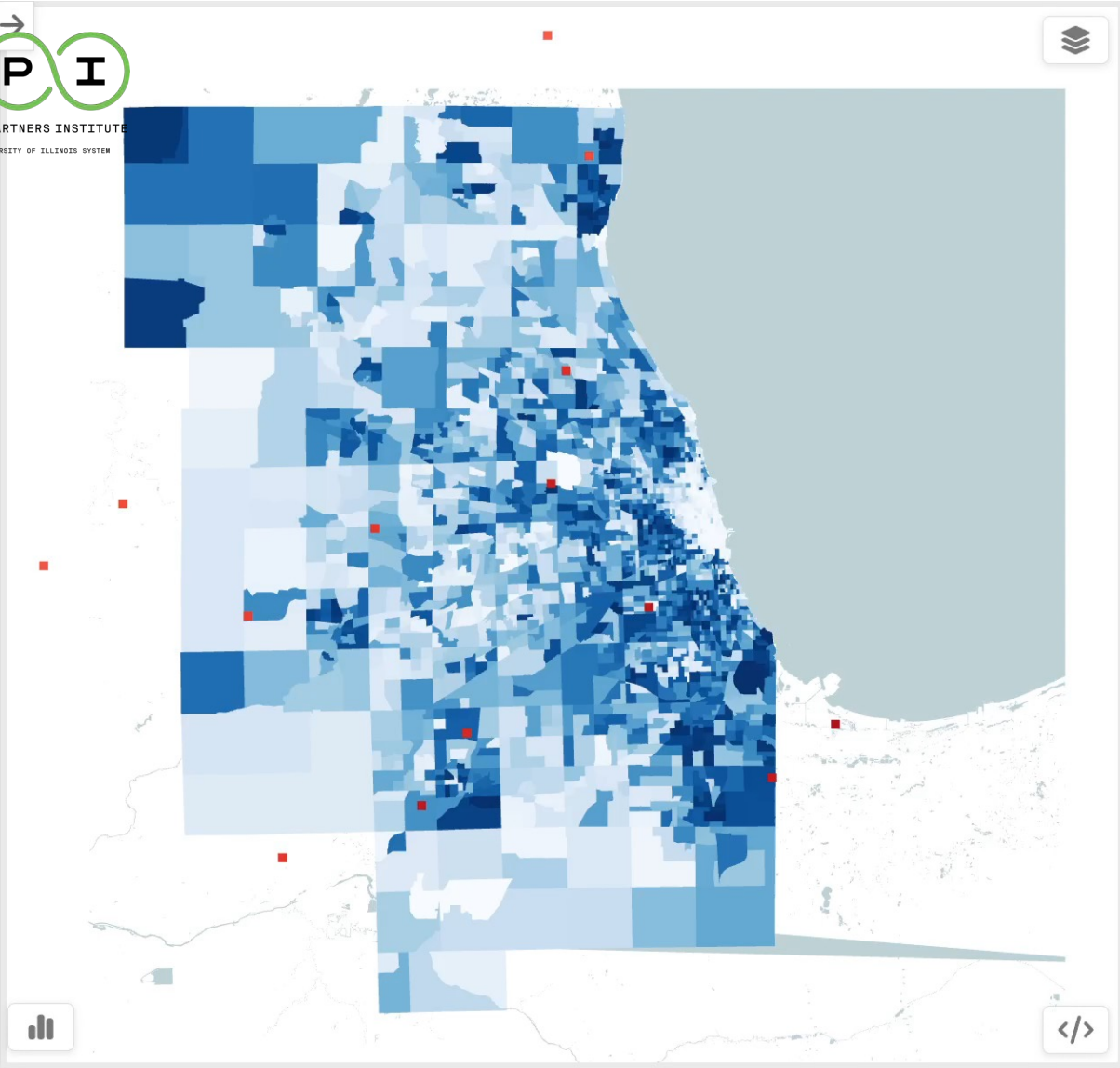

Layers

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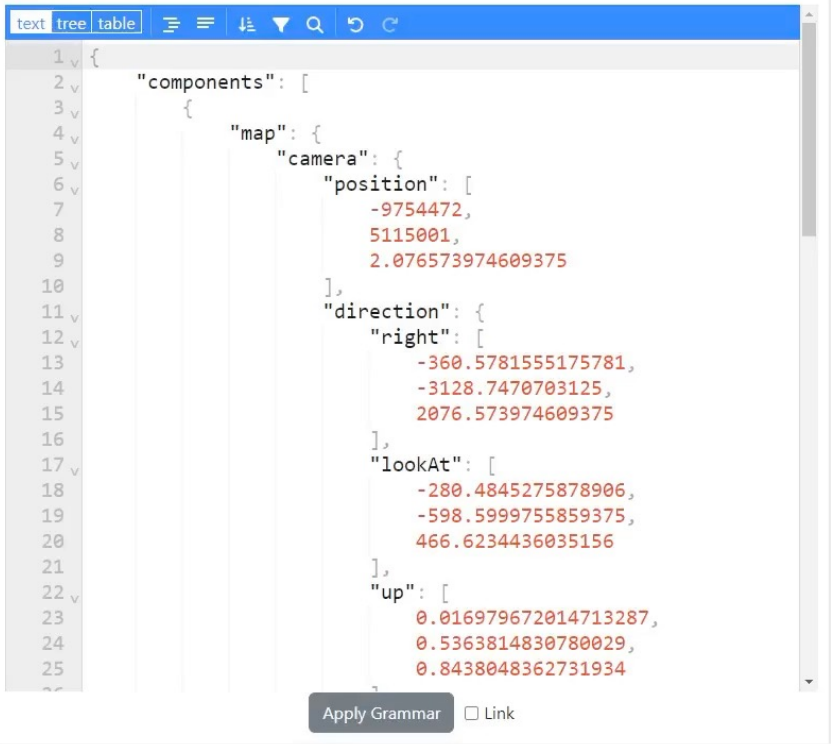

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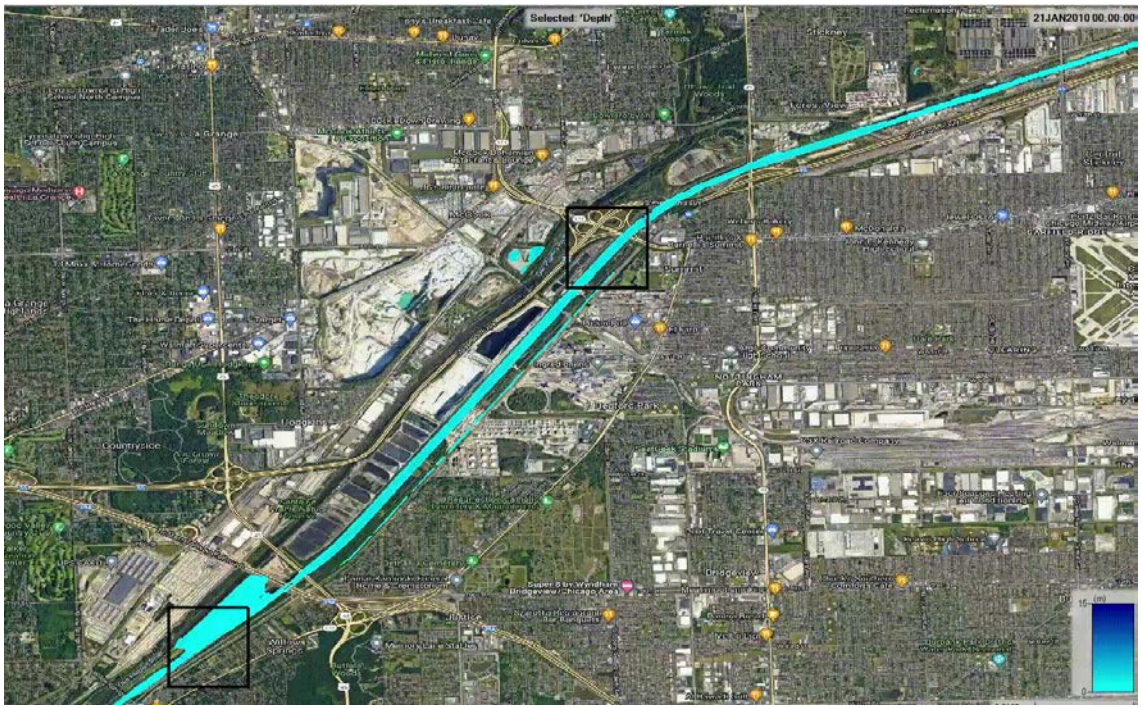
Urban Flood Forecasting

- Develop a high-resolution coupled hydrodynamic model to visualize flood propagation, identifying fine-scale flooding scenarios.
- Decision support system for early warning flood forecast system
- Engineered and nature-based solutions to mitigate flooding in urban cities.



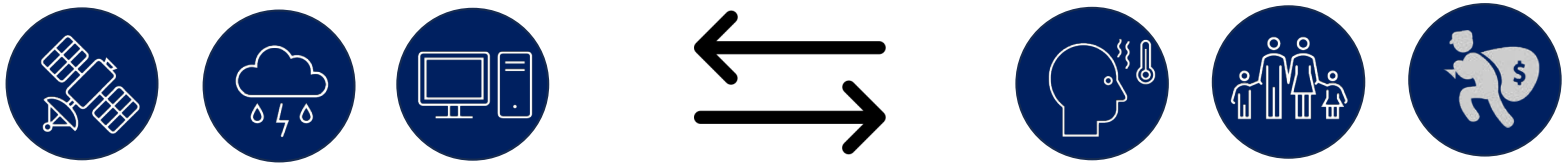
Conclusions and Next Steps

Online + New Data

flooding
meteorology
air quality

Models + Satellites

Story maps



Thank you

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