Visualizing Urban Accessibility

Investigating Multi-Stakeholder Perspectives through a Map-based Design Probe Study

On the job market!
Industry research

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CHI 2022

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MAKEABILITY LAB

DESIGN USE BUILD

PAUL G. ALLEN SCHOOL OF COMPUTER SCIENCE & ENGINEERING

UNIVERSITY of WASHINGTON


Urban Accessibility
Ease of reaching destinations or activities
Buildings
Transit
Pedestrian infrastructure

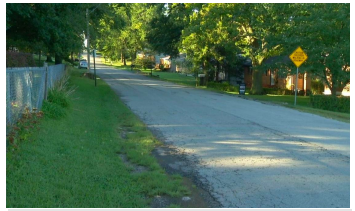
INTRODUCTION

APPROACH AND FOCUS

Missing Curb Ramps

Surface Issues

Obstacles



No Sidewalks

Sidewalk Problems

APPROACH AND FOCUS

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Sidewalk Problems

.gov

- Policymakers
- Department officials
- Accessibility Advocates
- People with mobility disabilities
- Caregivers

Stakeholders

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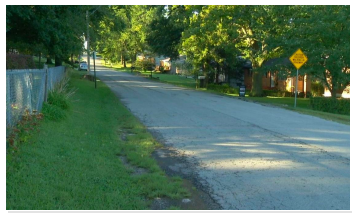

No Sidewalks

Sidewalk Problems

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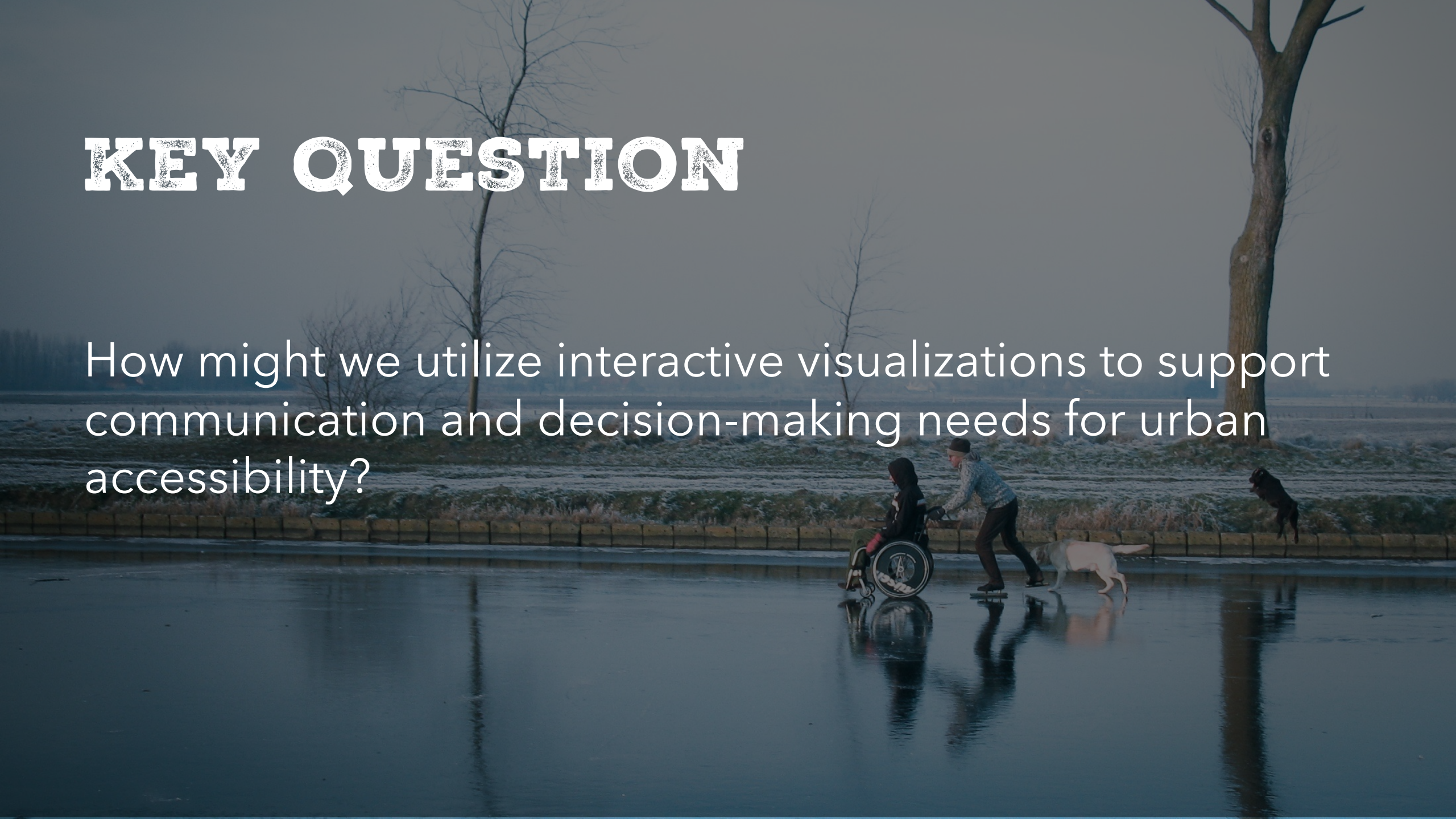
Stakeholders

People using Mobility Aids

MI individuals

Target Community

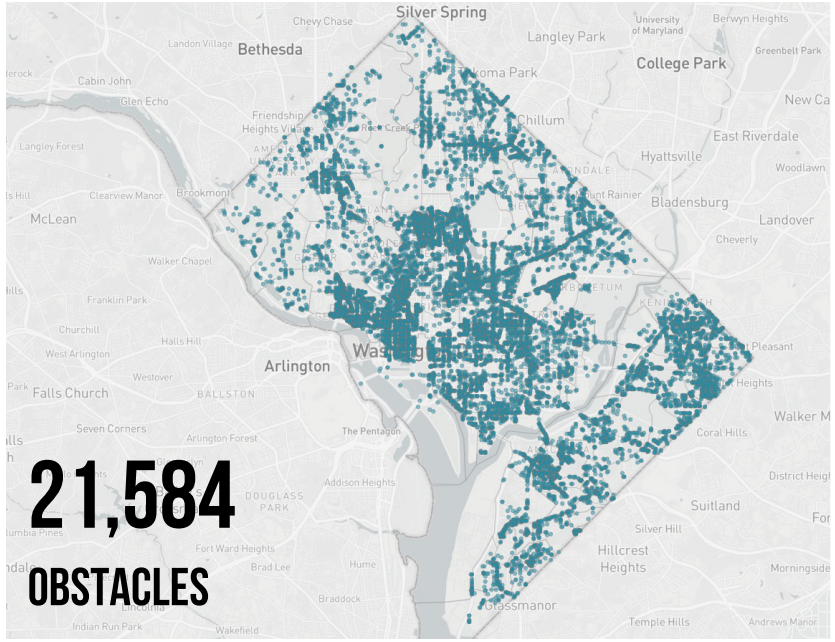


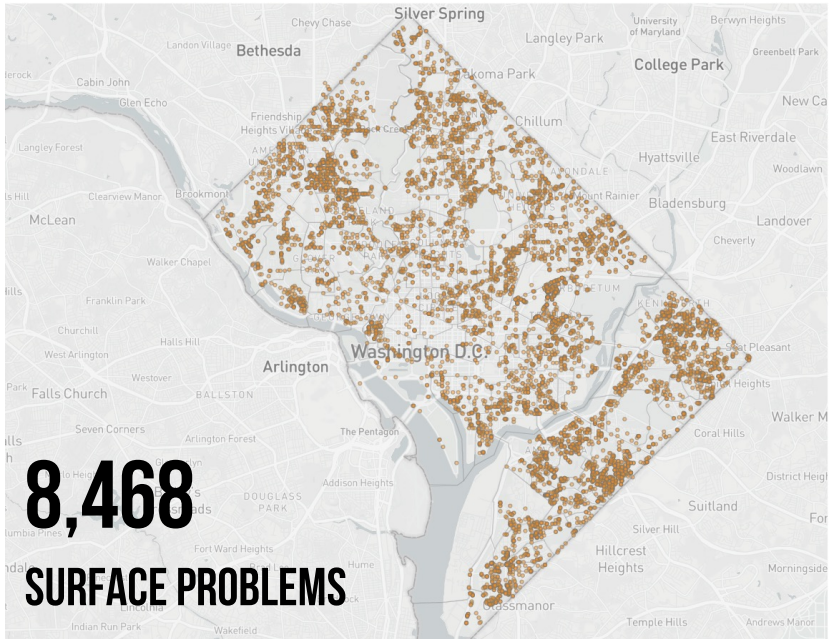
KEY QUESTION

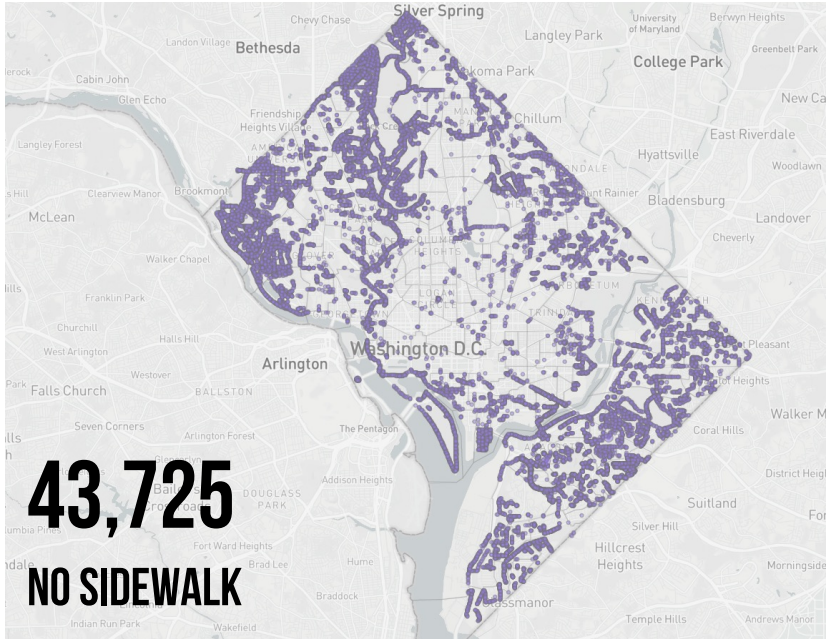
How might we utilize interactive visualizations to support communication and decision-making needs for urban accessibility?

INTRODUCTION

URBAN ACCESSIBILITY VISUALIZATIONS







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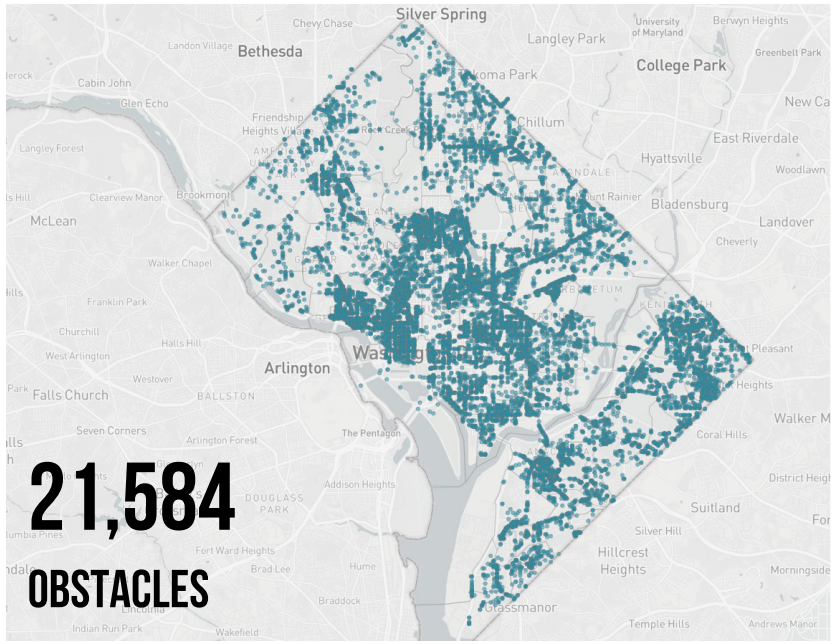
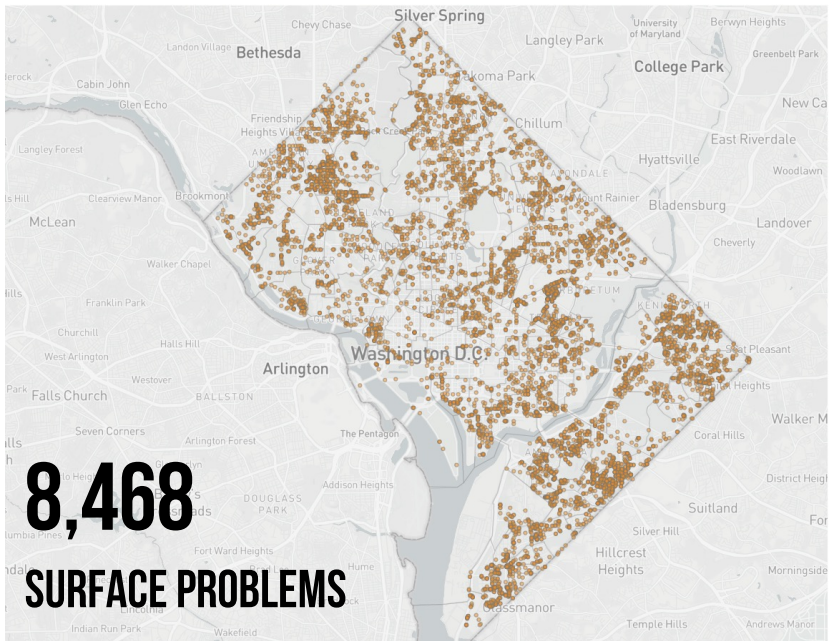
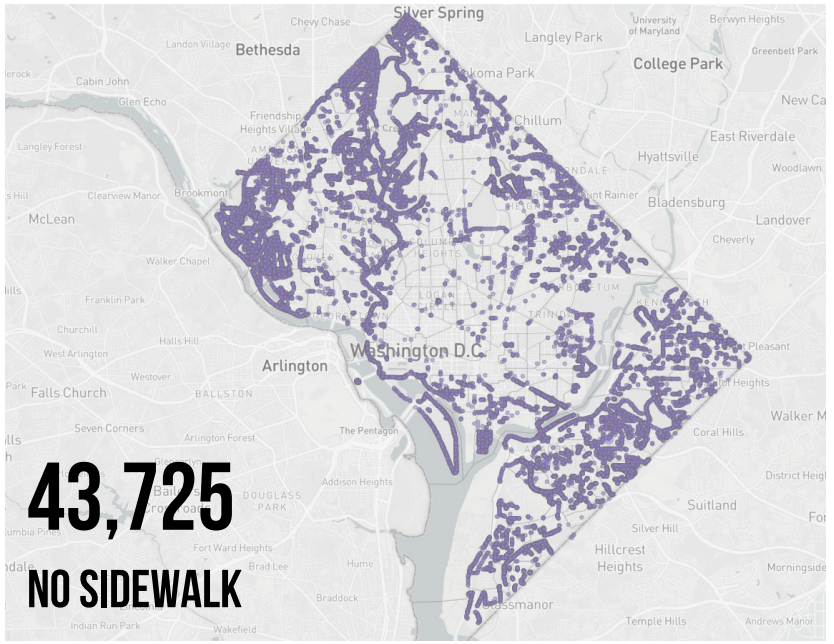






Where are the (in)accessible areas of the city?

Why are they (in)accessible?

Where are the areas with highest repair needs?

PROBLEM: STAKEHOLDERS' VISUALIZATION NEEDS

Understanding **how** stakeholders want to visualize and analyze urban accessibility datasets

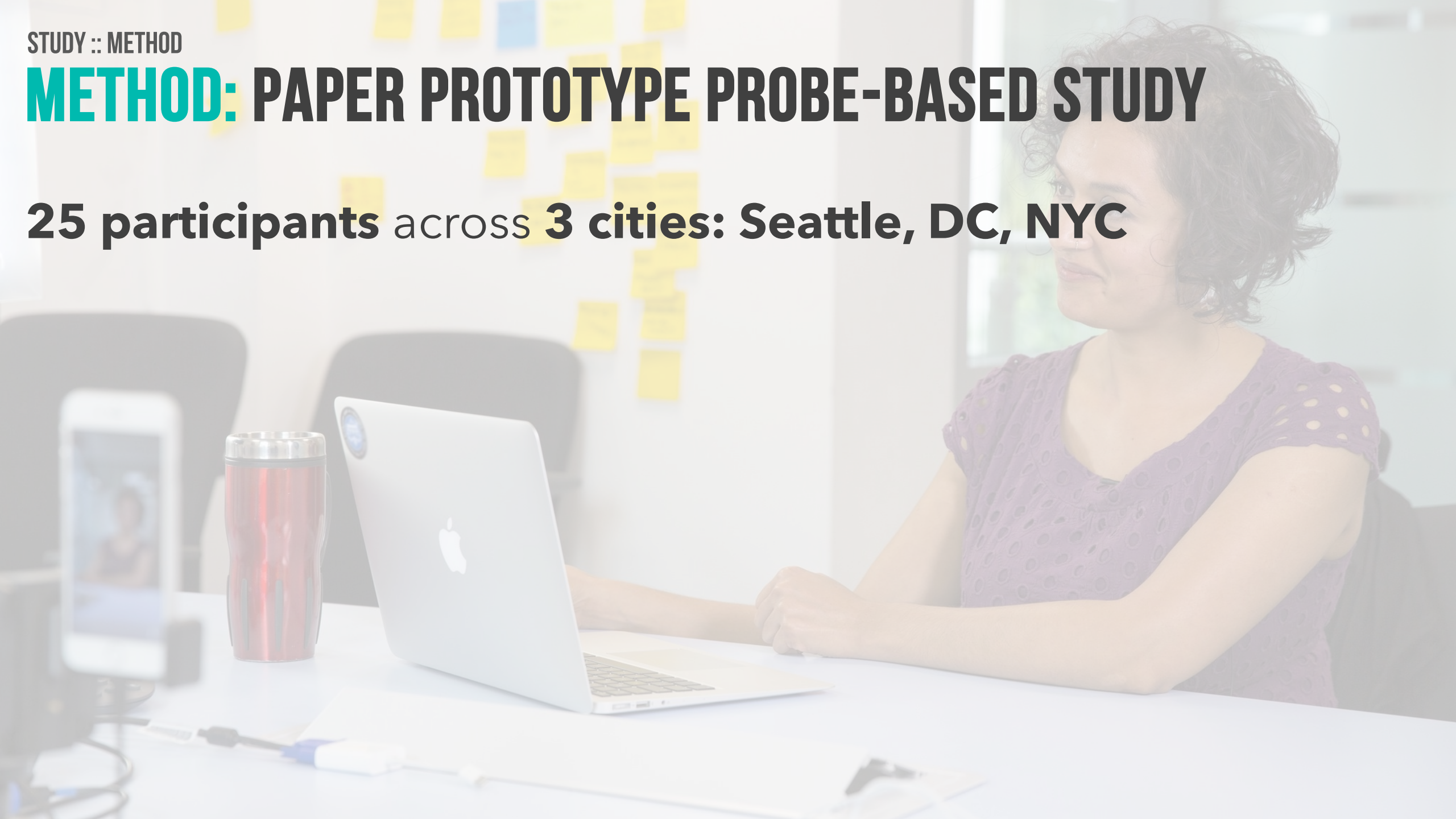
STUDY: RESEARCH QUESTIONS

RQ1 What are the key visual analytic tasks and data needs for urban accessibility?

RQ2 How might key stakeholders' sensemaking practices differ?

METHOD: PAPER PROTOTYPE PROBE-BASED STUDY

25 participants across **3 cities: Seattle, DC, NYC**



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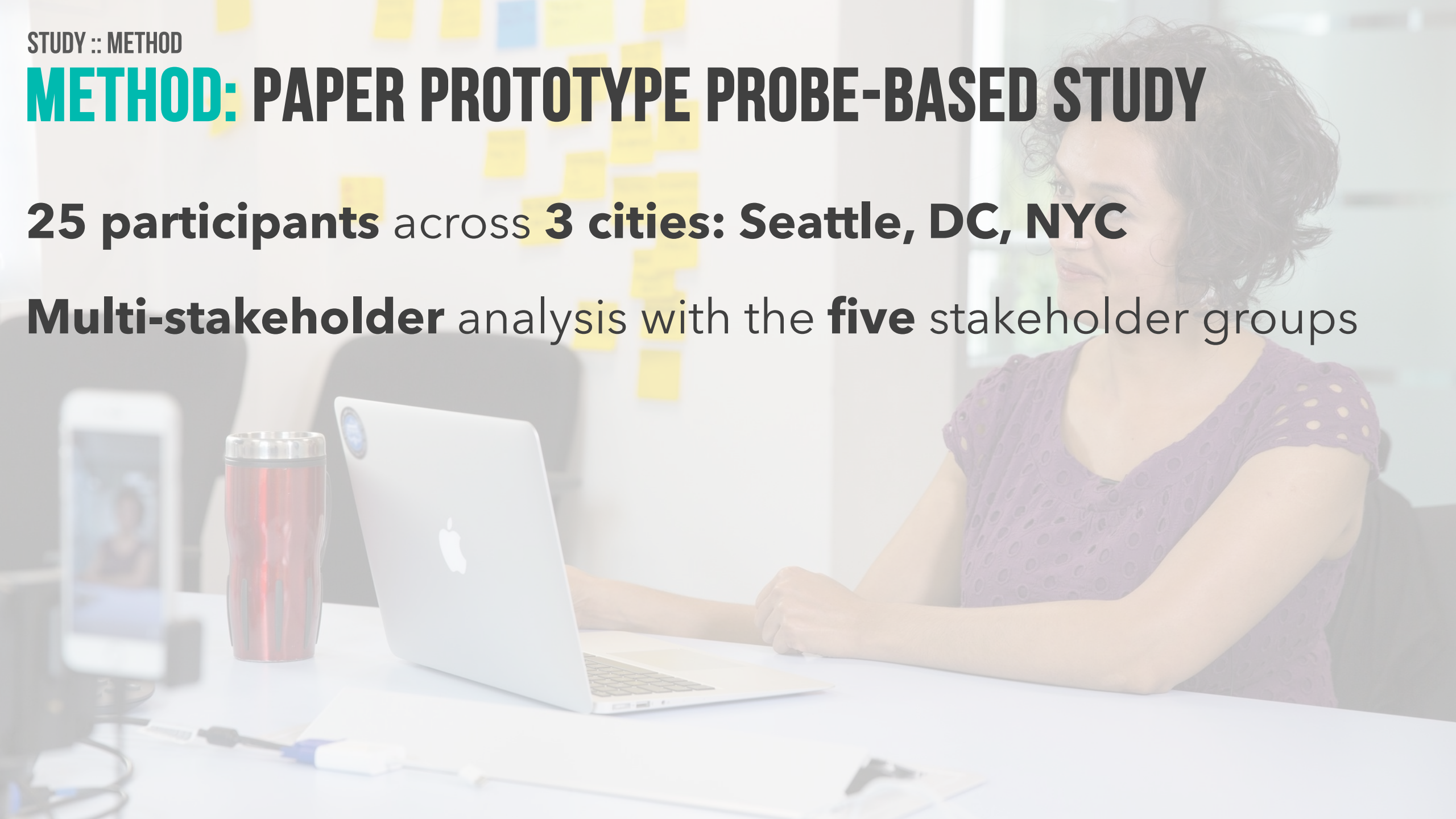
Multi-stakeholder analysis with the **five** stakeholder groups



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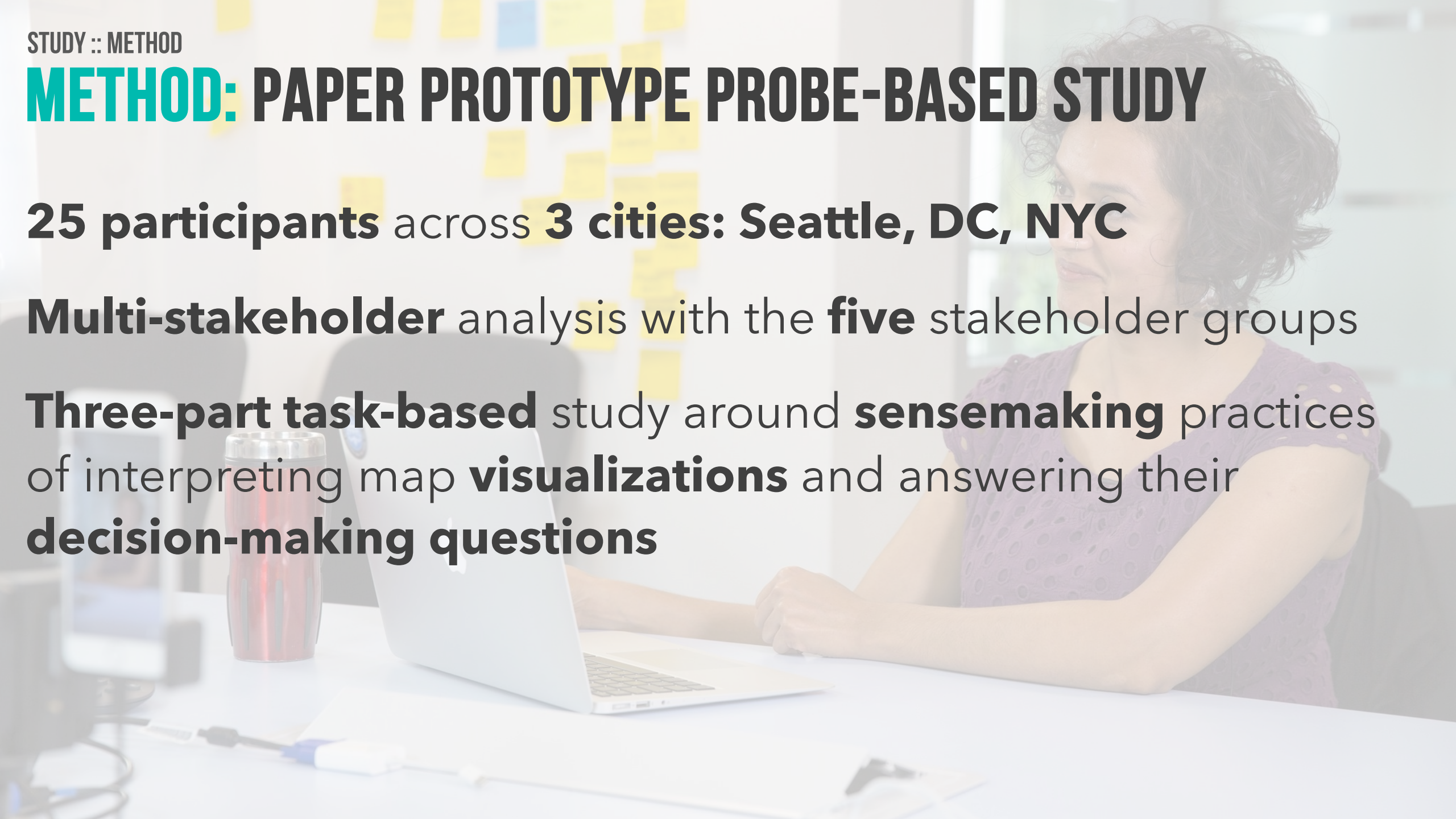
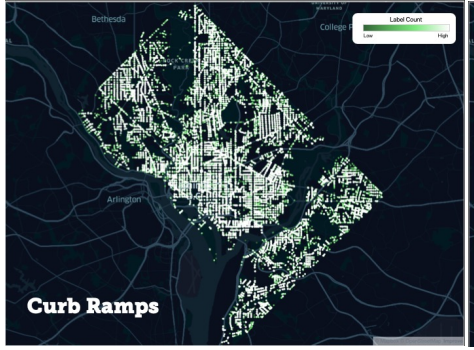
Multi-stakeholder analysis with the **five** stakeholder groups

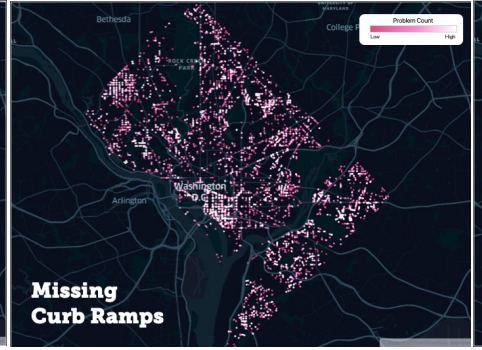
Three-part task-based study around **sensemaking** practices of interpreting map **visualizations** and answering their **decision-making questions**

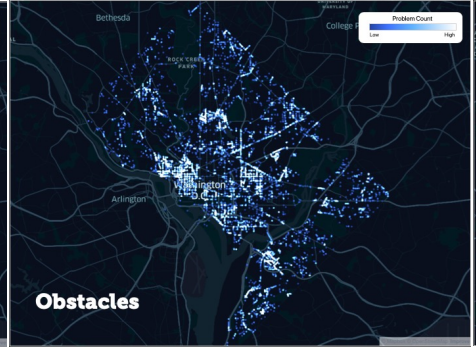


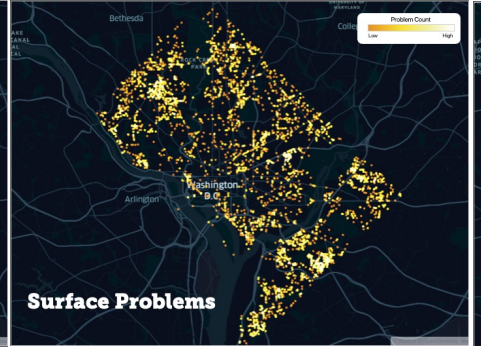
Map Visualizations as Design Probes

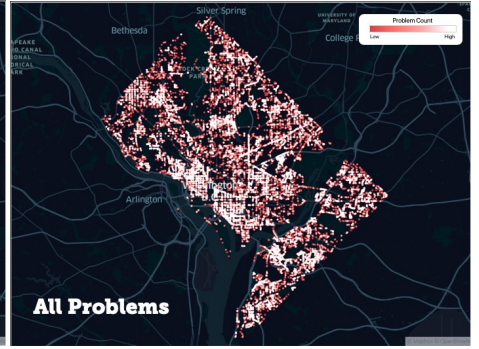
Type 1: Point-based



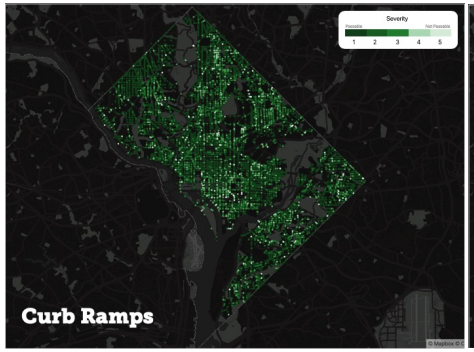


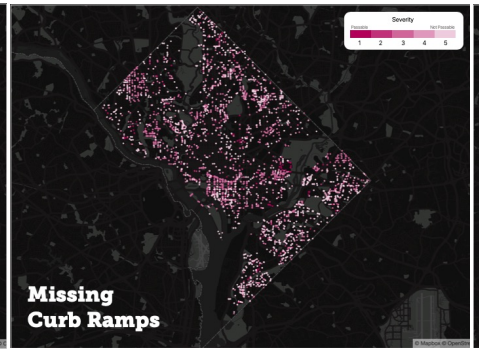


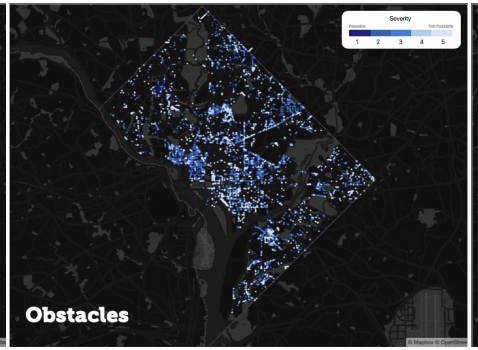


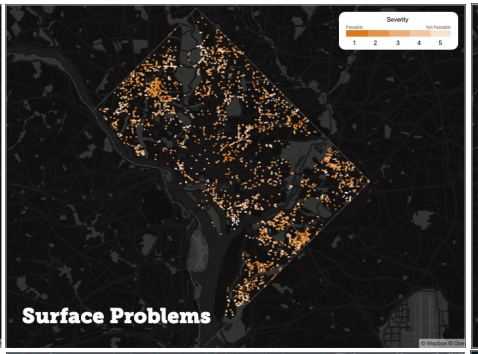


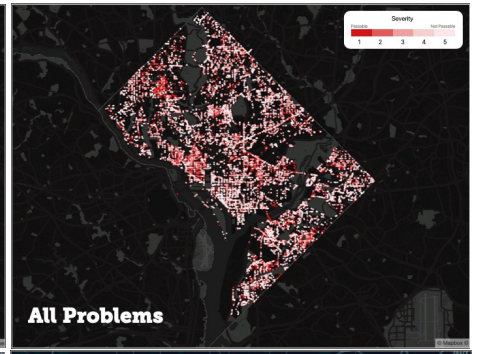
Type 2: Severity Point-based



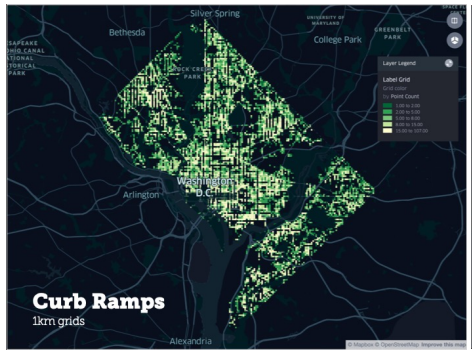


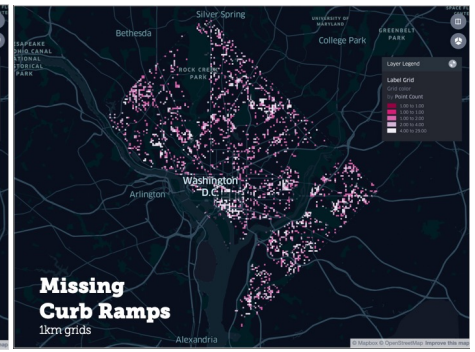


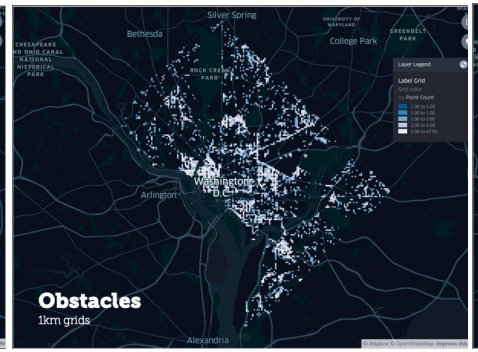


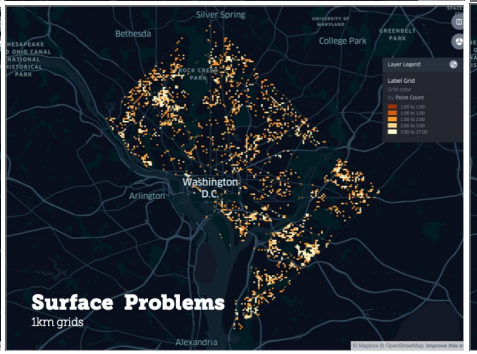


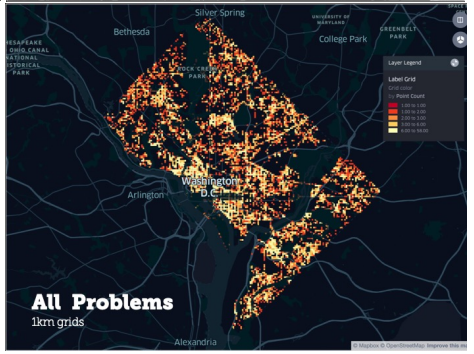
Type 3: Grid Maps



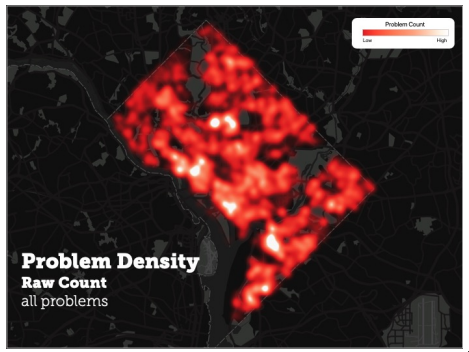


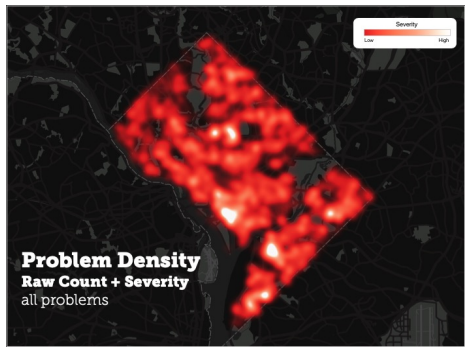




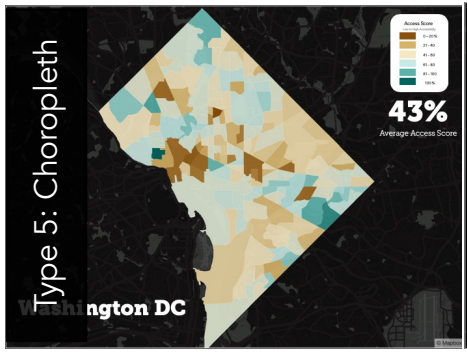


Type 4: Heatmaps

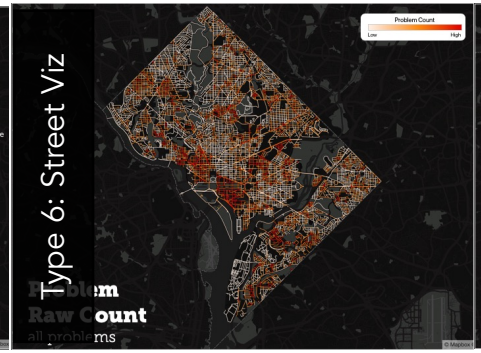


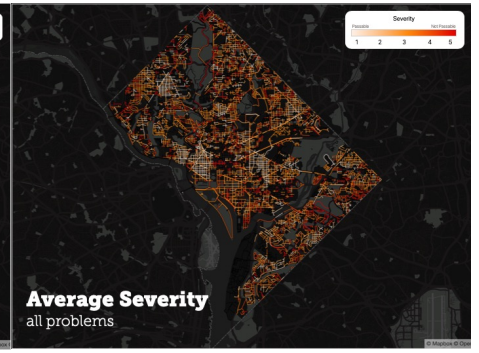


Type 5: Choropleth



Type 6: Street Viz

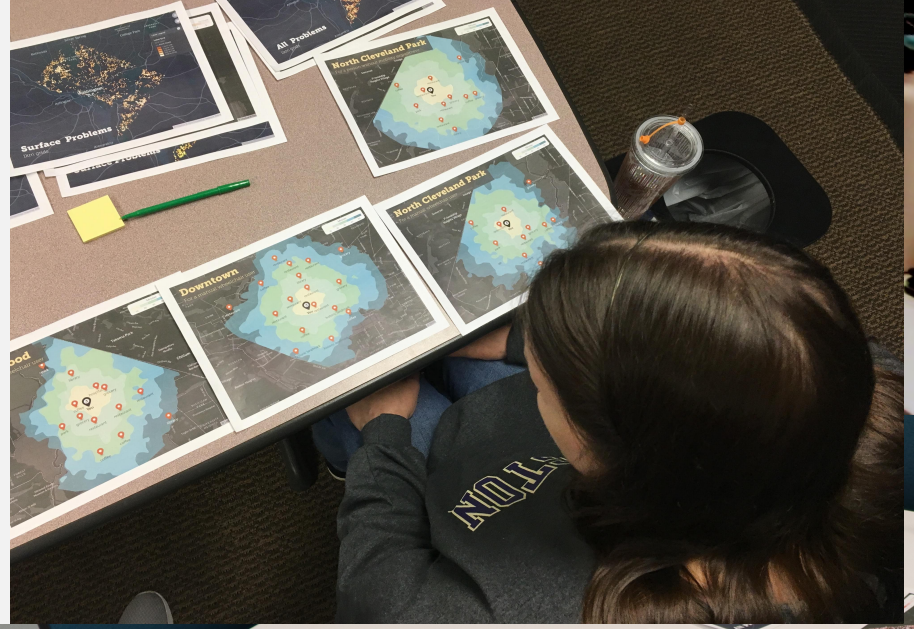


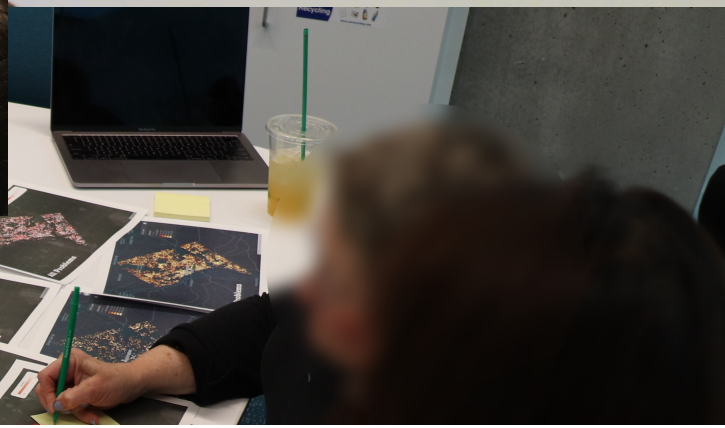


DESIGN INTERVIEWS

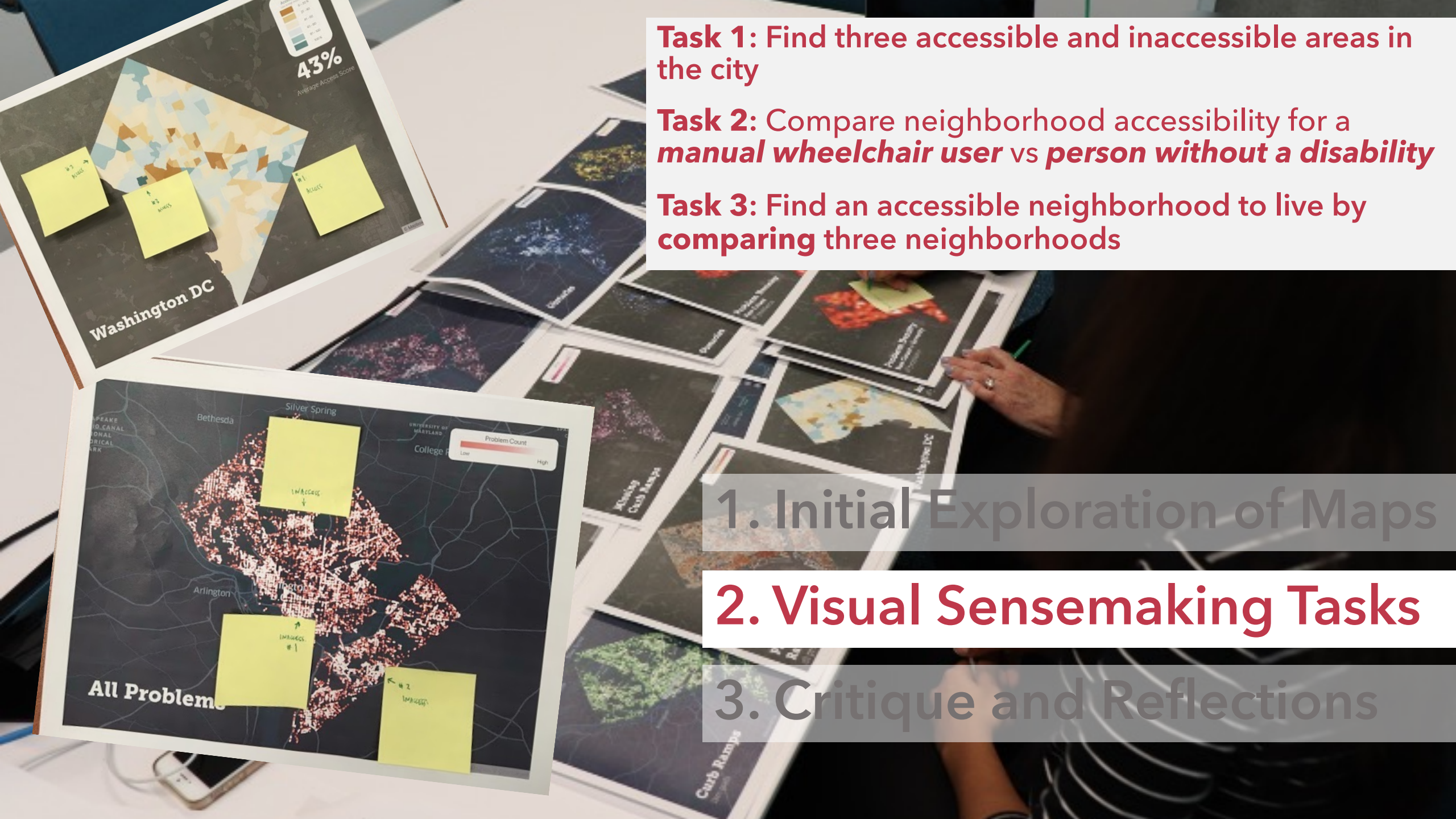
N=25

Department officials (e.g., DOTs)
Policymakers (e.g., elected officials)
Accessibility advocates (e.g., NGOs)
People with mobility disabilities
Caregivers





1. Initial Exploration of Maps
2. Visual Sensemaking Tasks
3. Critique and Reflections



Task 1: Find three accessible and inaccessible areas in the city

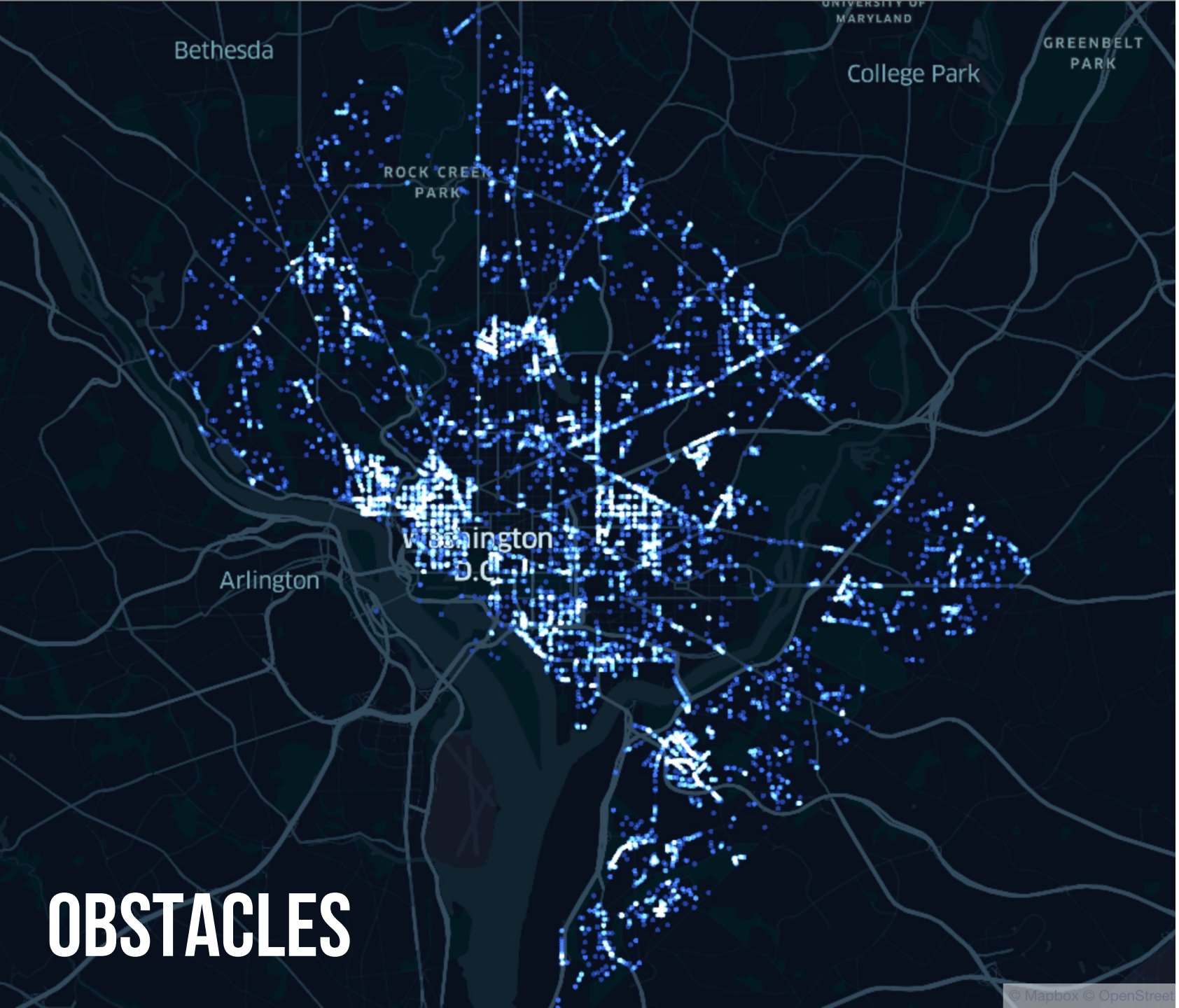
Task 2: Compare neighborhood accessibility for a ***manual wheelchair user*** vs ***person without a disability***

Task 3: Find an accessible neighborhood to live by **comparing** three neighborhoods

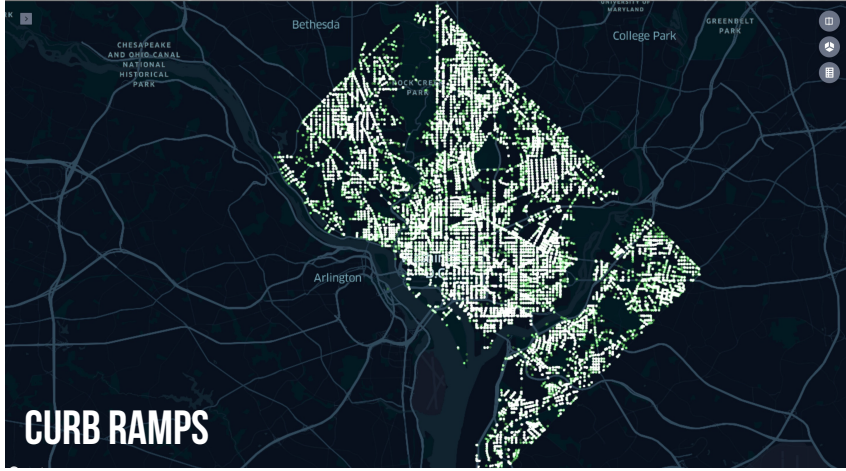
1. Initial Exploration of Maps

2. Visual Sensemaking Tasks

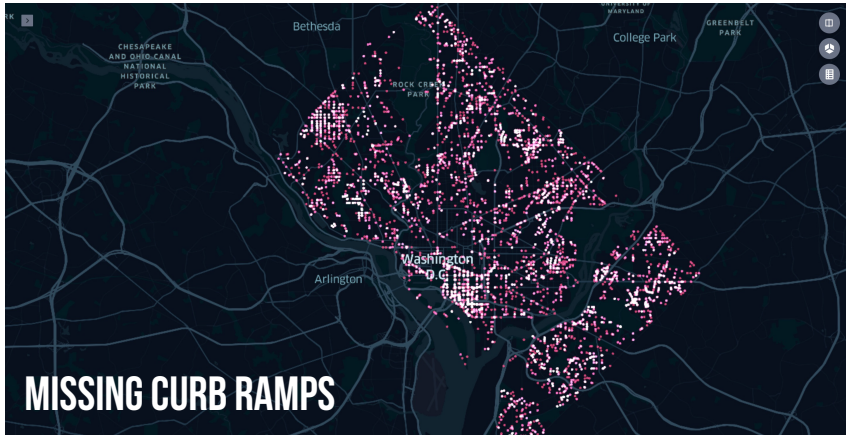
3. Critique and Reflections



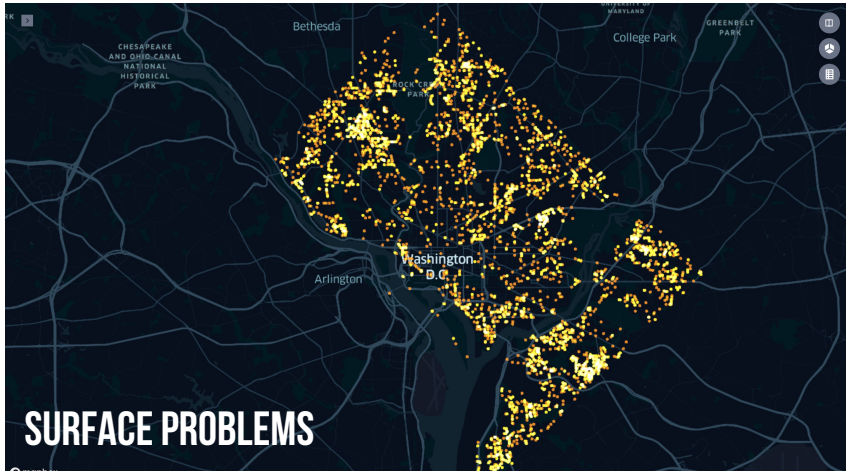
OBSTACLES



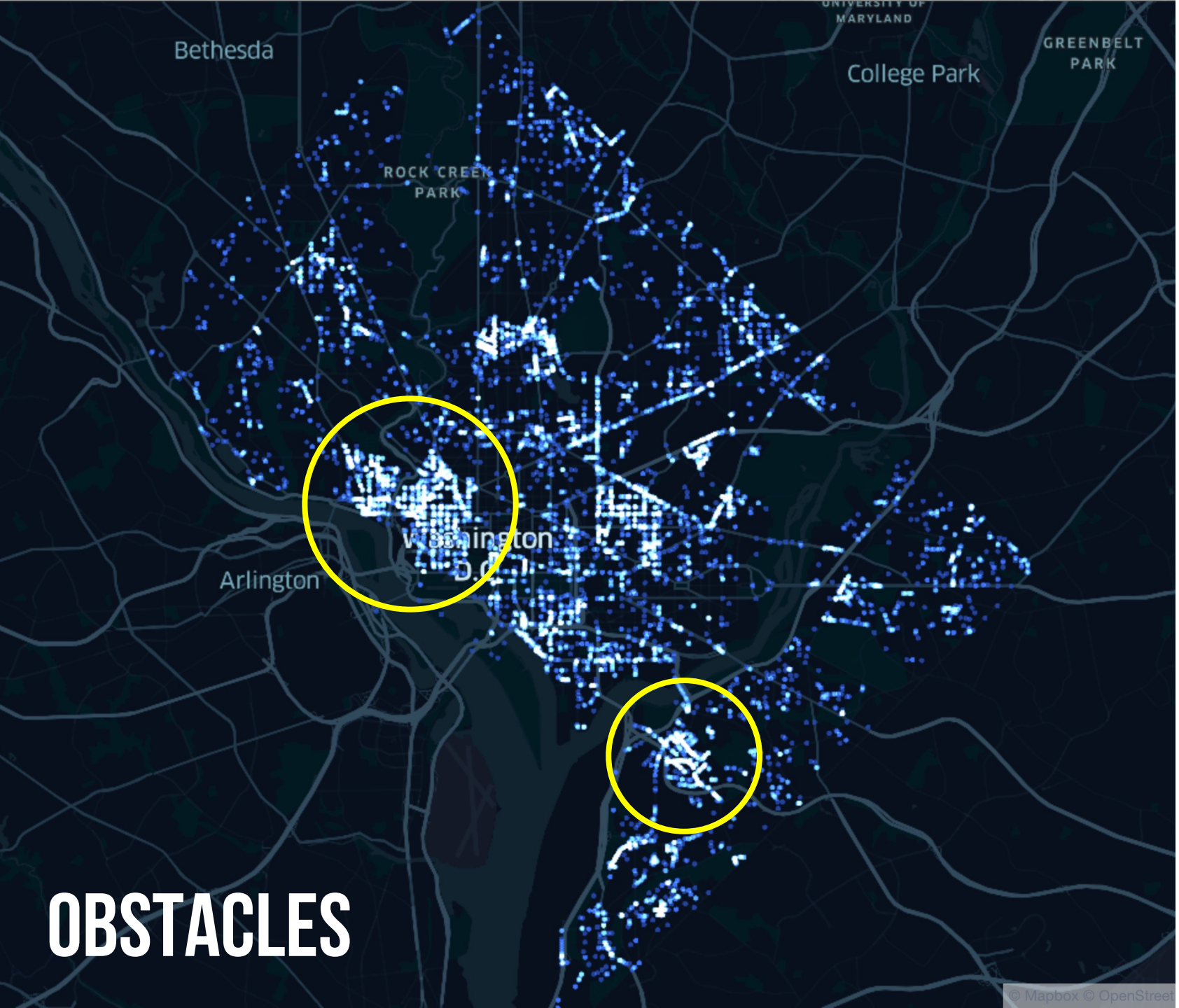
CURB RAMPS



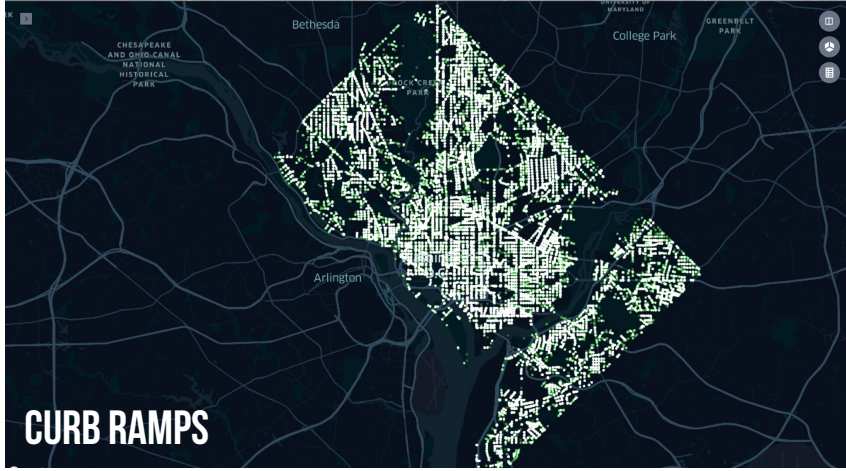
MISSING CURB RAMPS



SURFACE PROBLEMS


Bethesda
College Park
GREENBELT PARK
ROCK CREEK PARK
Washington D.C.
Arlington
© Mapbox © OpenStreet

OBSTACLES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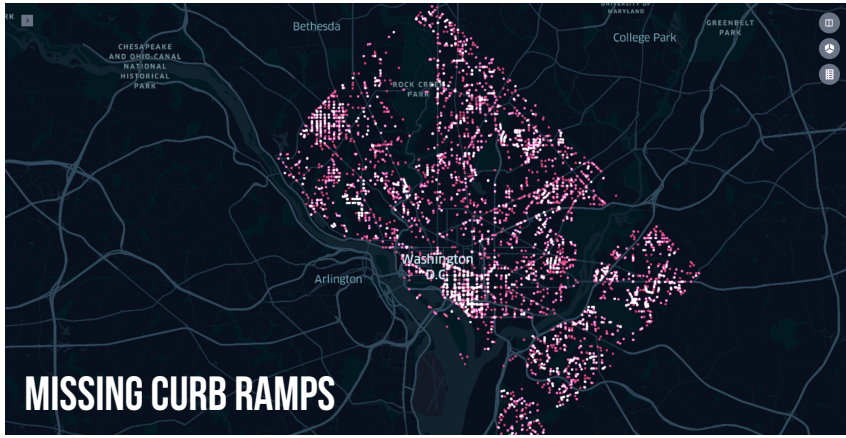
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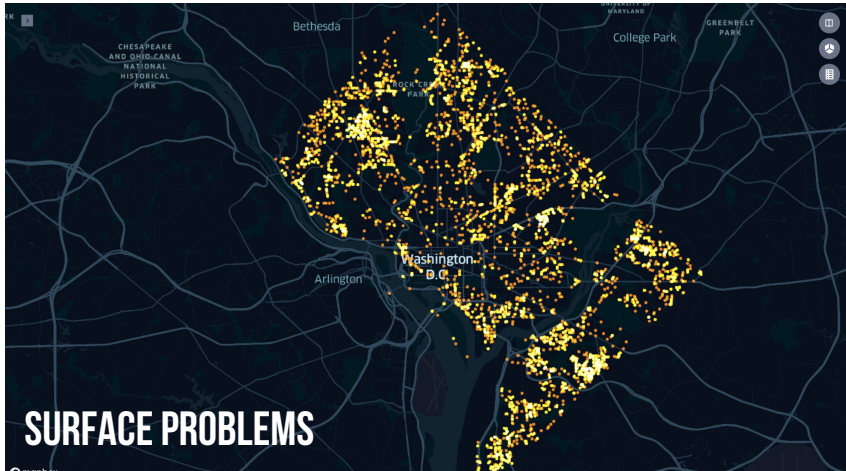
Bethesda
College Park
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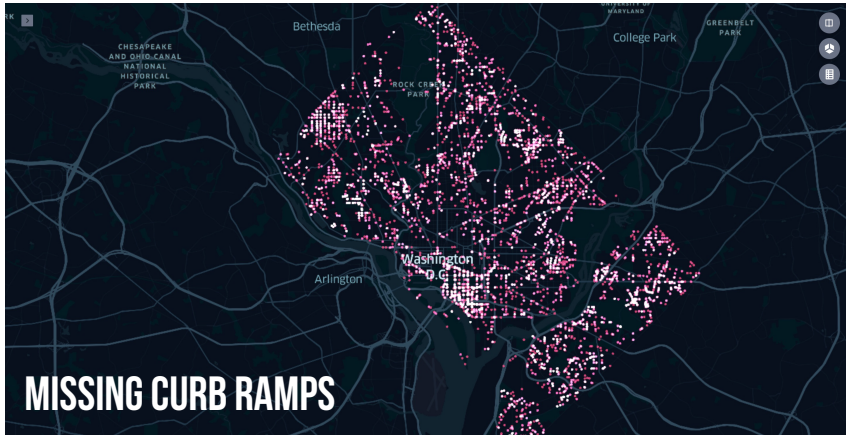
SURFACE PROBLEMS

Why are we seeing this?

OBSTACLES

CURB RAMPS



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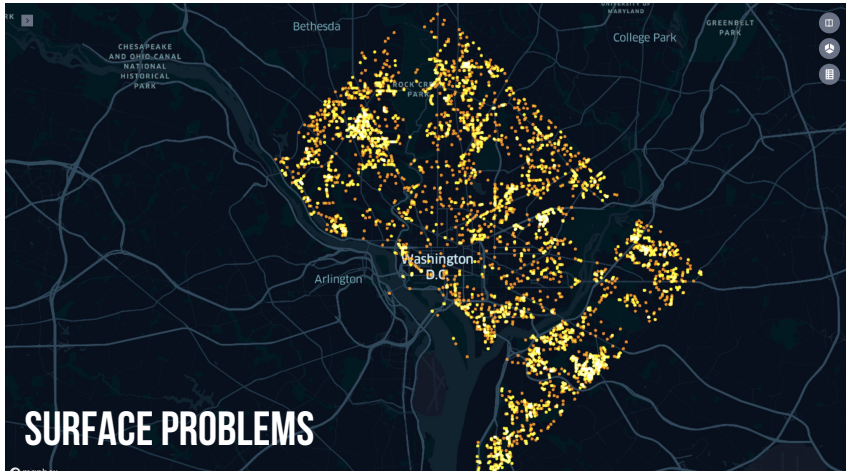

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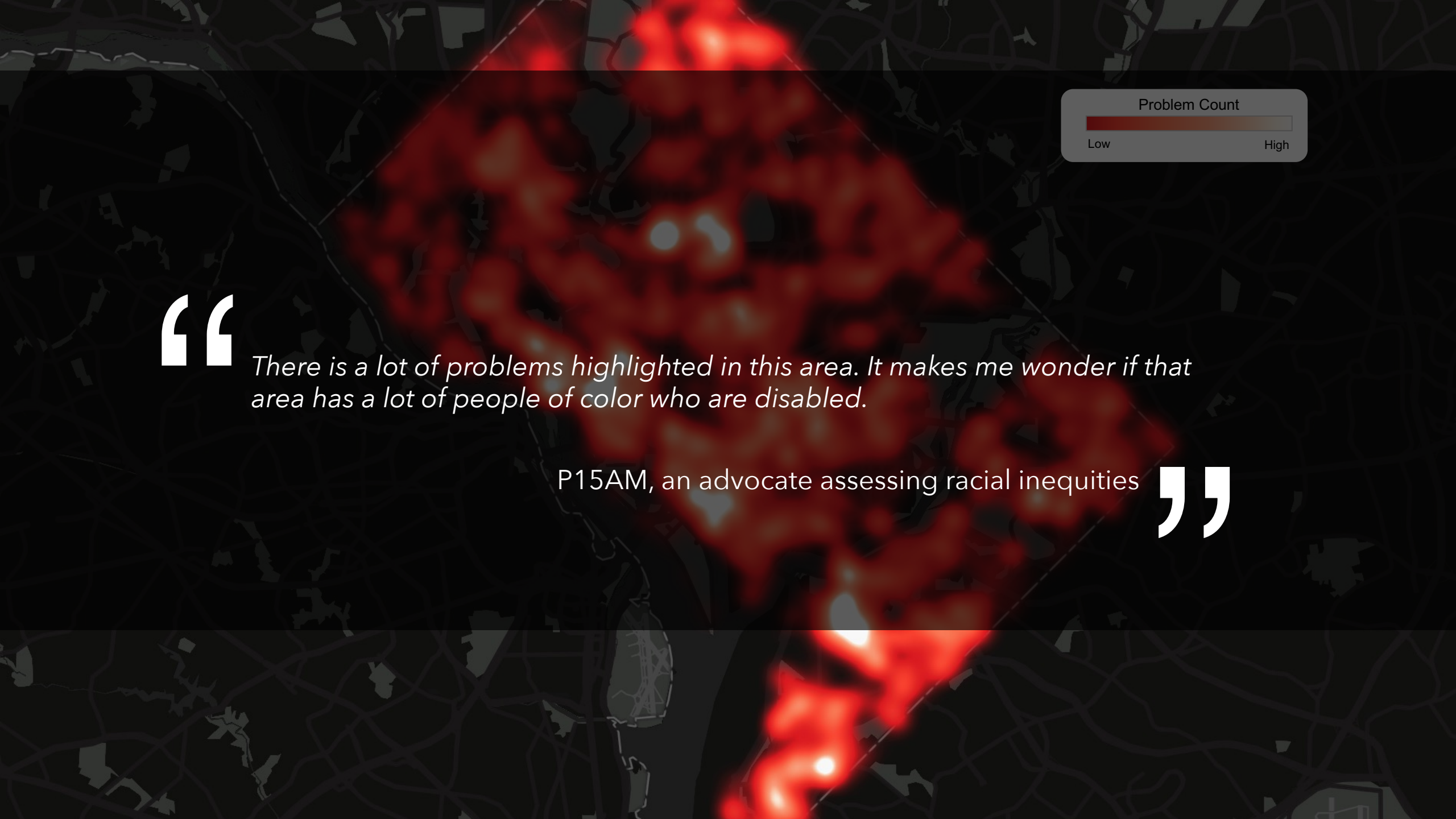


> *There is a lot of problems highlighted in this area. It makes me wonder if that area has a lot of people of color who are disabled.*
>
> P15AM, an advocate assessing racial inequities

Socio-economic factors
Historic factors
Temporal factors

Problem Count

Low High

Georgetown

Highly affluent, historic area
82% White, 8.7% Asian, 6.2% Black

Anacostia

Lower socio-economic area,
92% Black, 5% Non-Hispanic White, 3% Other

FINDINGS: CATEGORIES

Key
Data + Task Needs
RQ1

Sensemaking
practices and differences
RQ2

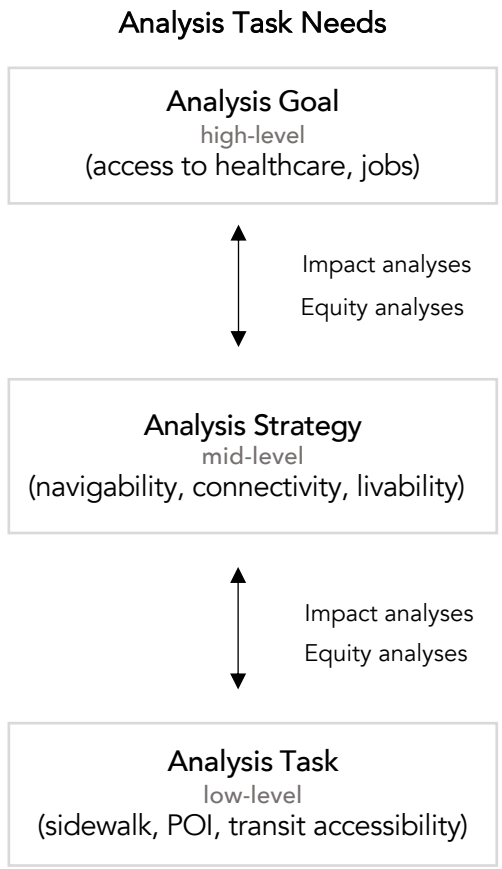
FINDINGS: CATEGORIES

Key
Data + Task Needs
RQ1

Sensemaking
practices and differences
RQ2

RQ1: KEY VISUAL ANALYTIC TASKS AND DATA NEEDS

Diverse set of analysis tasks across stakeholder groups



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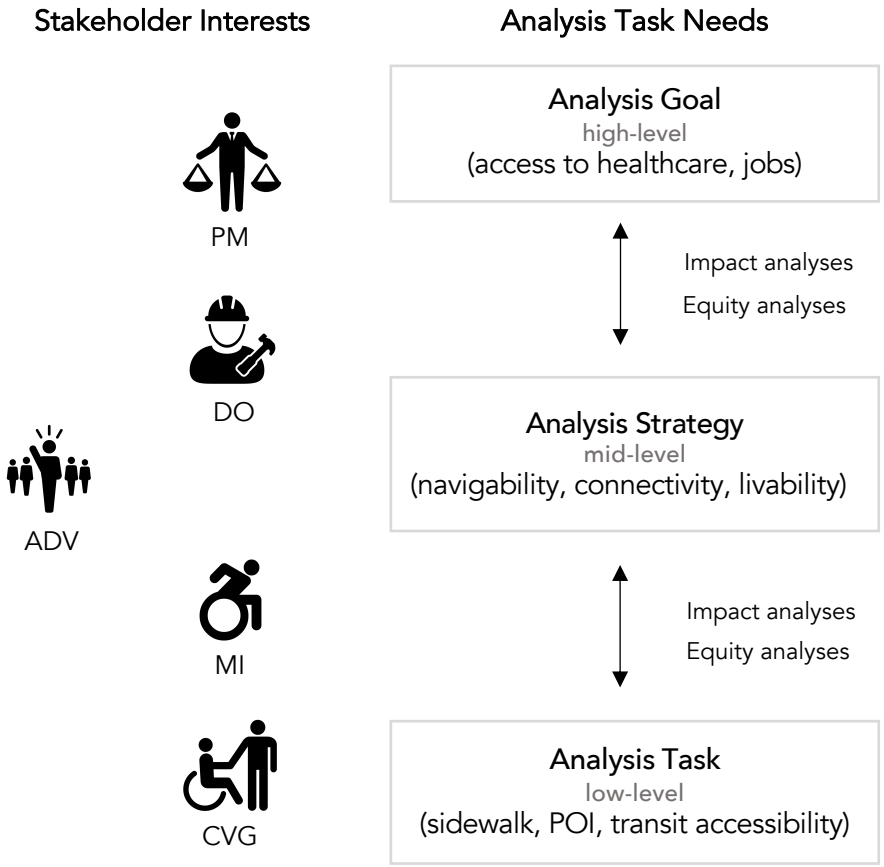

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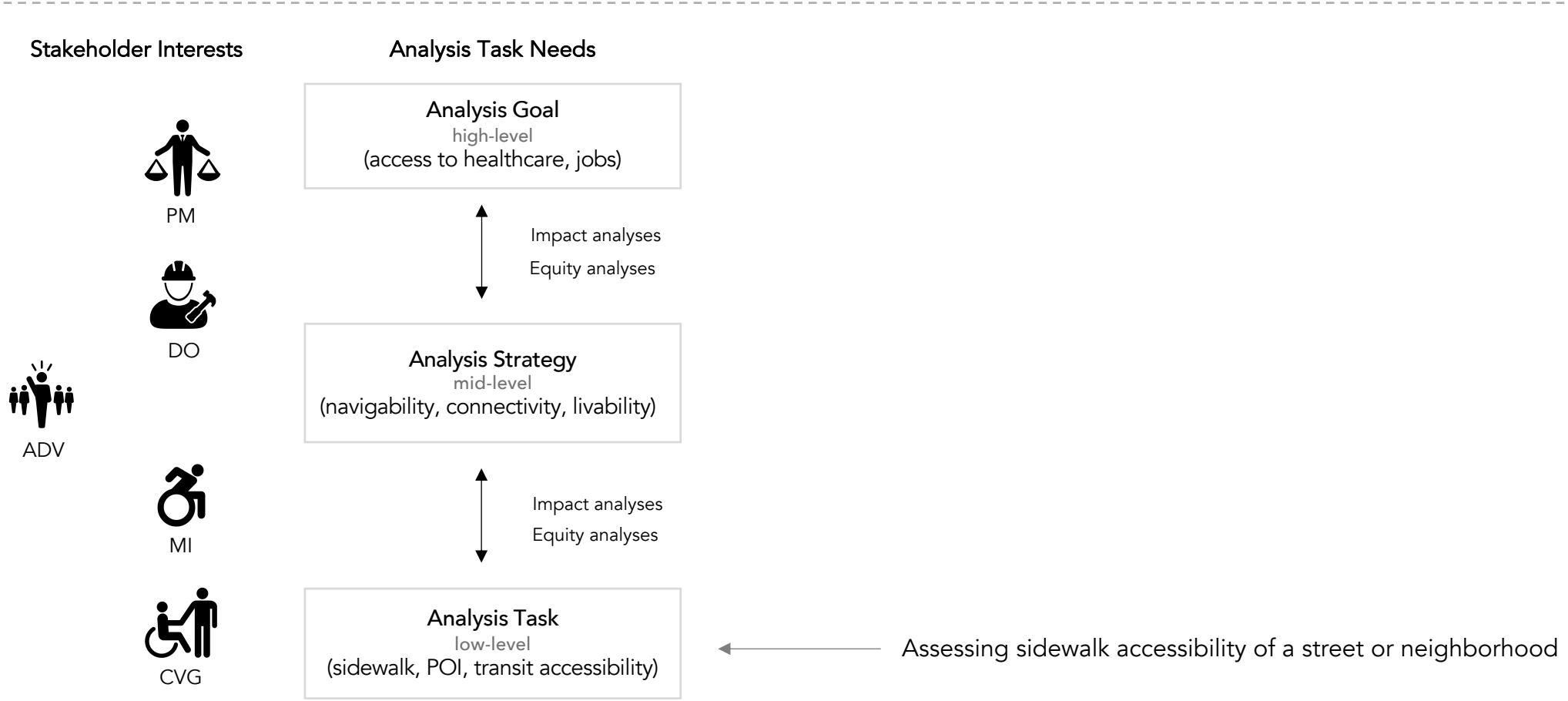

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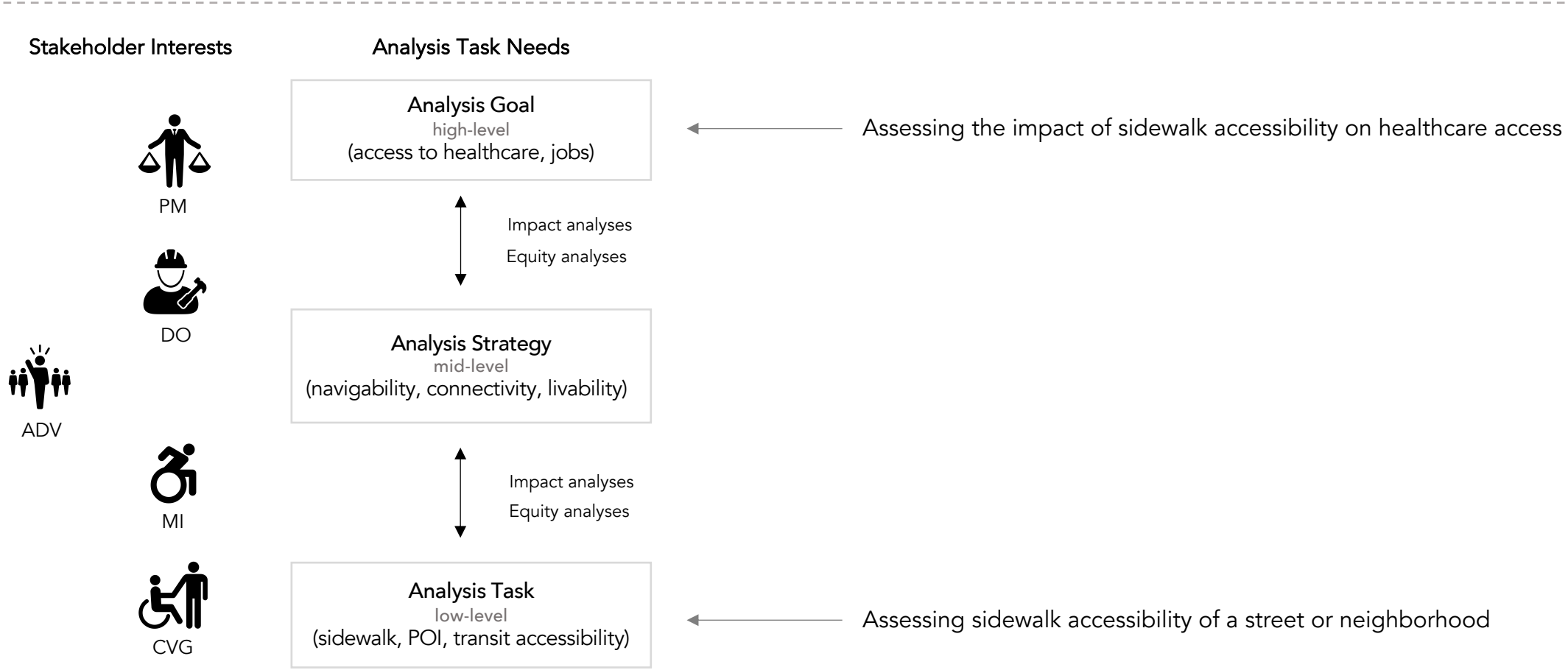
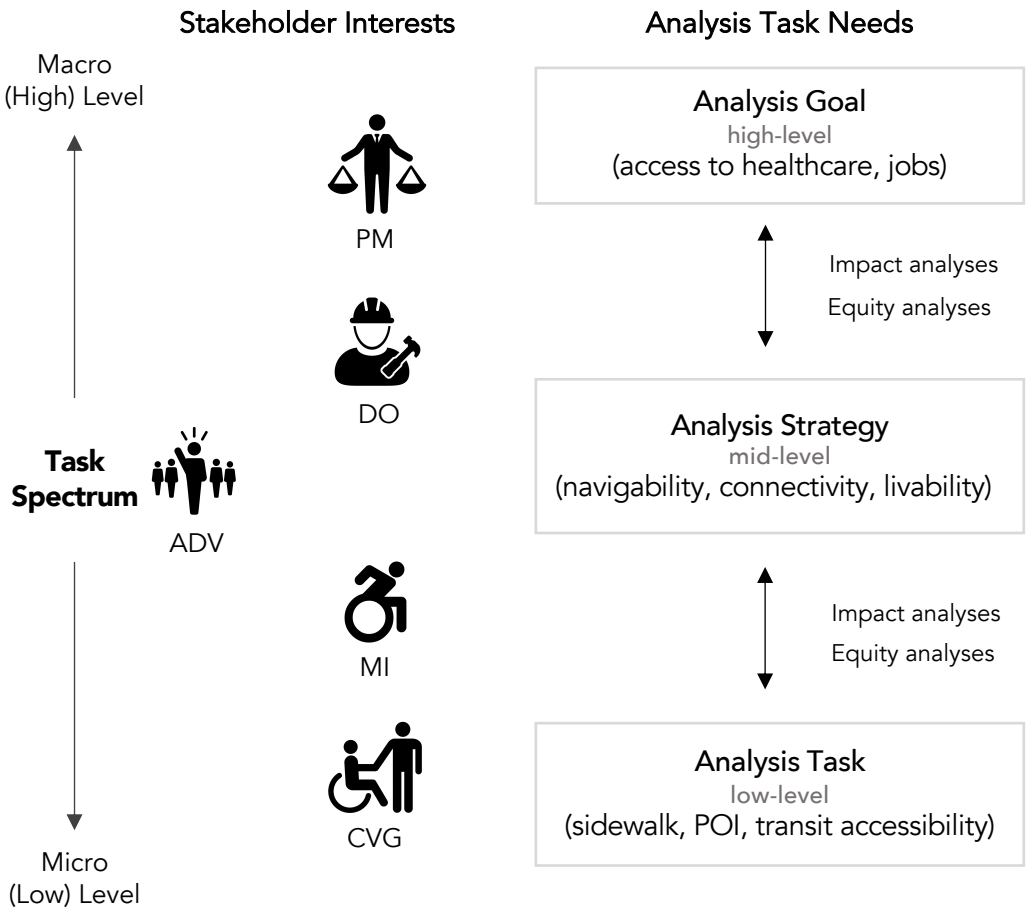


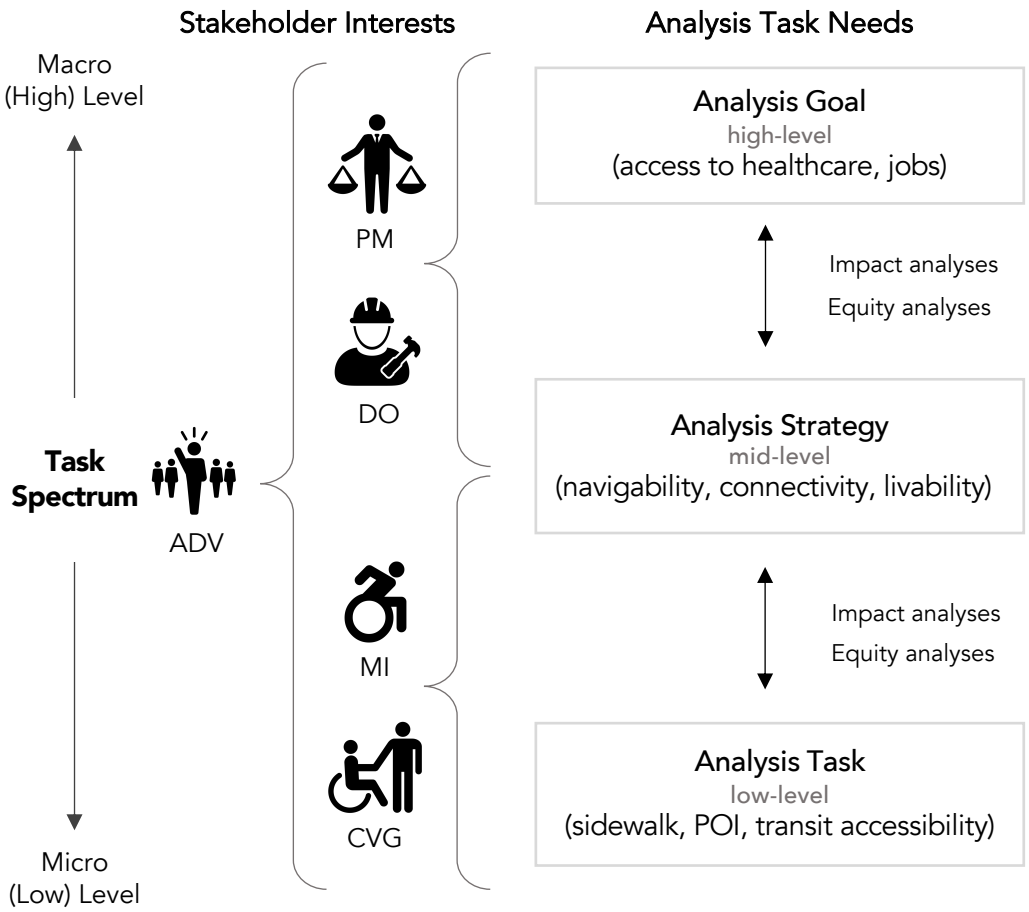
RQ1: KEY VISUAL ANALYTIC TASKS AND DATA NEEDS

The tasks are on a spectrum from micro- to macro-level tasks with few shared tasks across stakeholders



RQ1: KEY VISUAL ANALYTIC TASKS AND DATA NEEDS

The tasks are on a spectrum from micro- to macro-level tasks with few shared tasks across stakeholders



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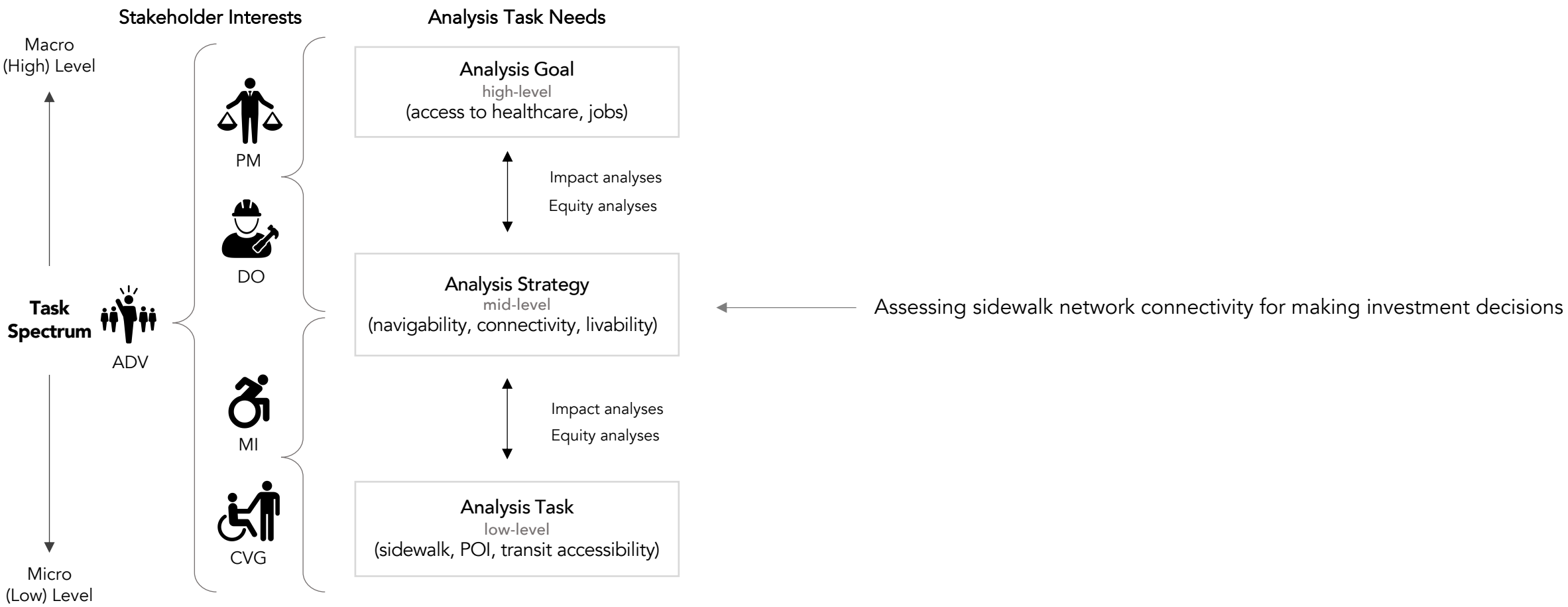
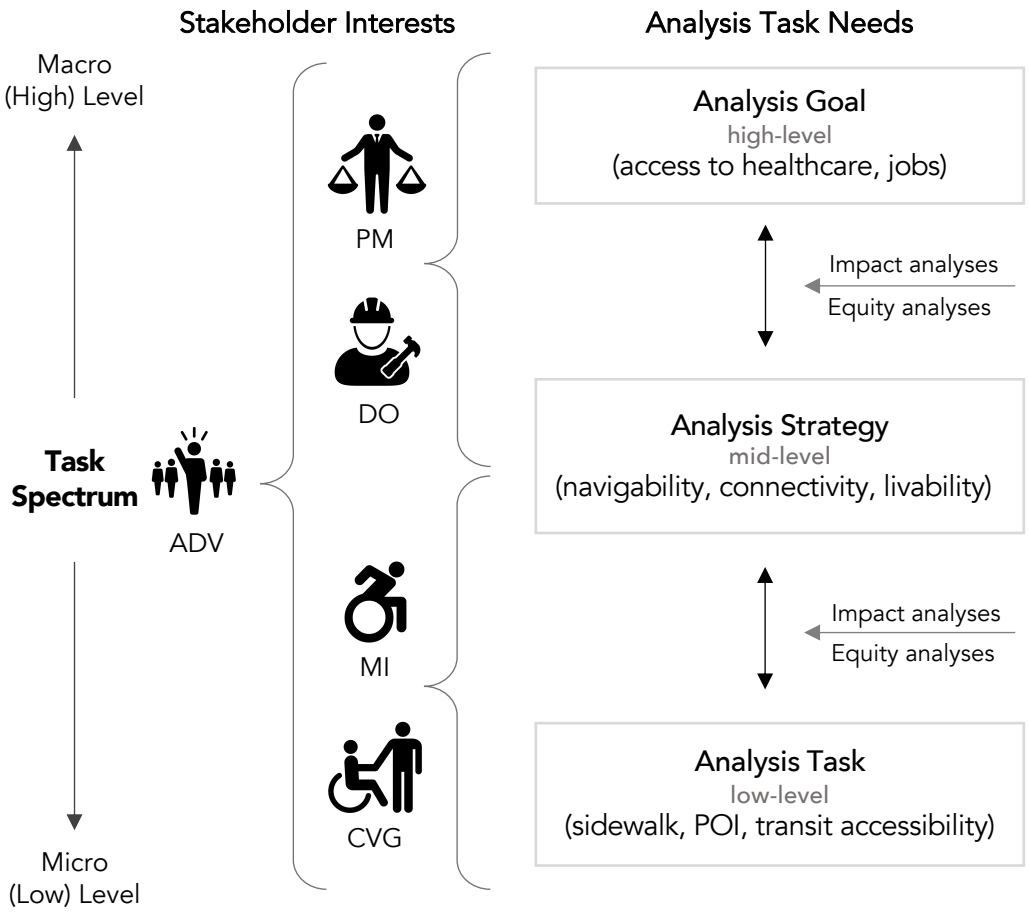


RQ1: KEY VISUAL ANALYTIC TASKS AND DATA NEEDS

Diverse assessment factors needed to be balanced for making decisions across these contexts

MULTI-LAYERED TASK MODEL FOR URBAN ACCESSIBILITY



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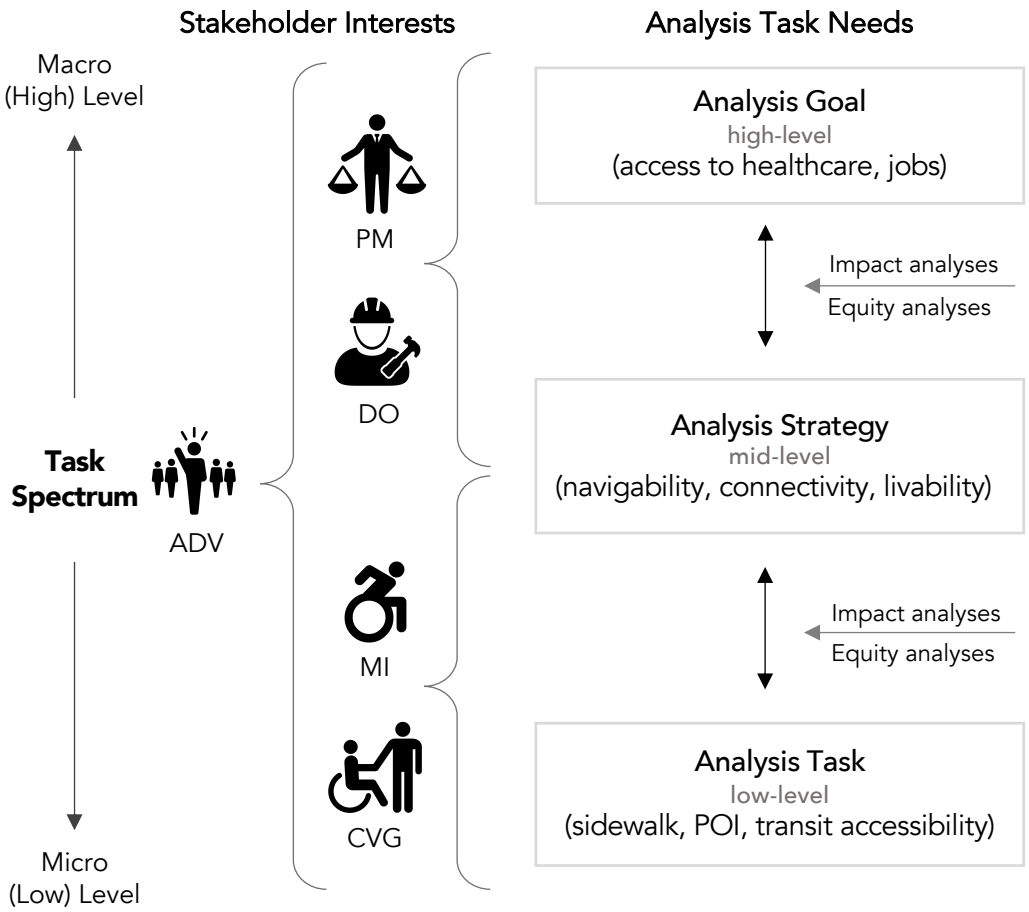

Data Needs	
Quantitative Datasets	sidewalk accessibility data (e.g., raw problem count) population density (e.g., data on people with disabilities) demographics (e.g., racial distribution, income levels) topographical/terrain (e.g., elevation, slope) pedestrian traffic and collision data POI density (residential + business density) high-travelled destinations (POIs) job data (for people with disabilities) historical context (e.g., trends on investments made)
Qualitative Datasets	nature of problems (e.g., types of sidewalk obstacles) images of problems locations of POIs POI accessibility data (e.g., existence of stairs, elevators) lived experience testimonials about "feeling" of a place transit data (e.g., locations of metro stops) geographic features labels (e.g., parks, water bodies, major arterials)
Metrics	problem count, severity (raw metrics) total count, access scores, priority scores (aggregated/modeled metrics)

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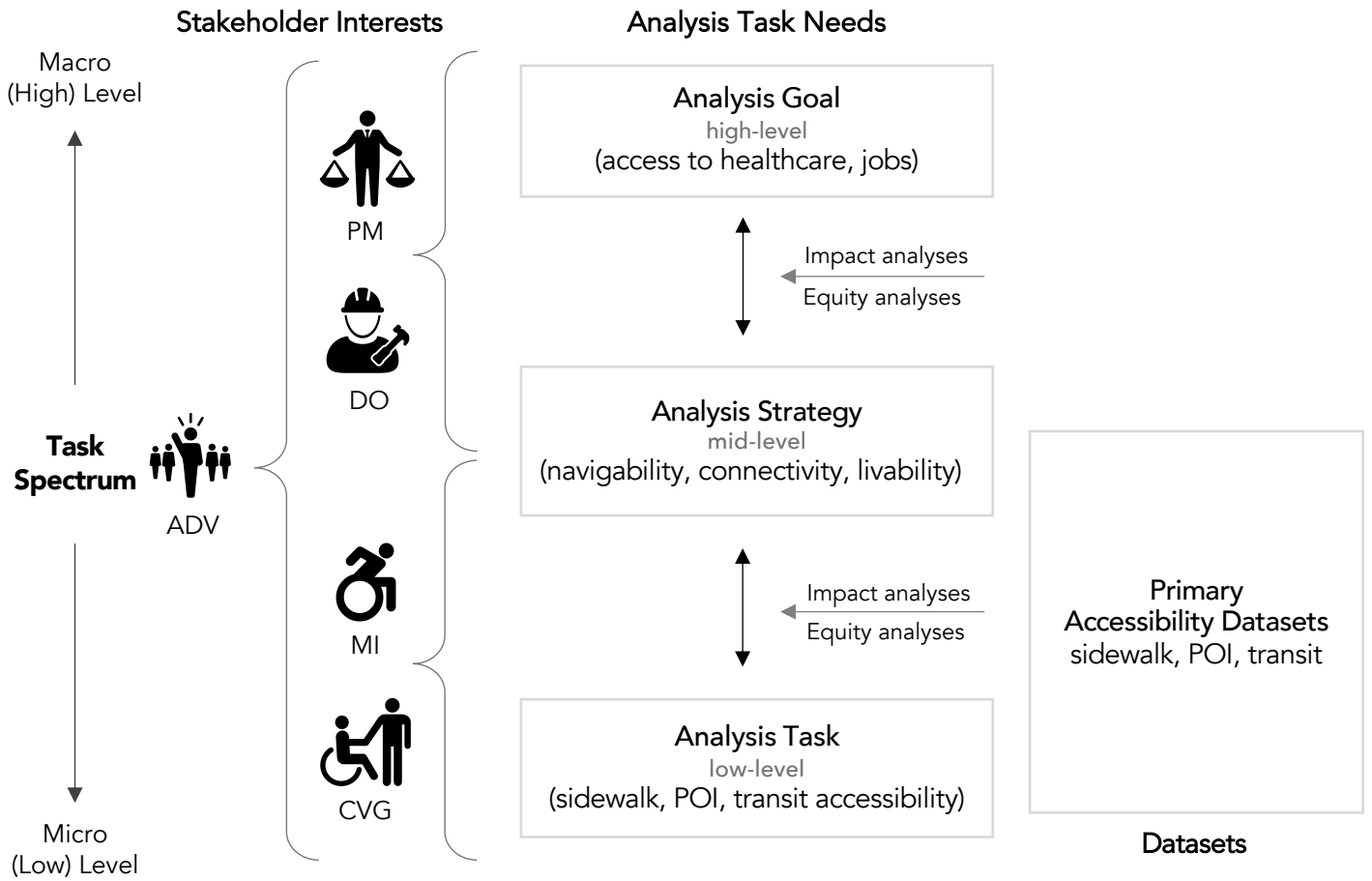

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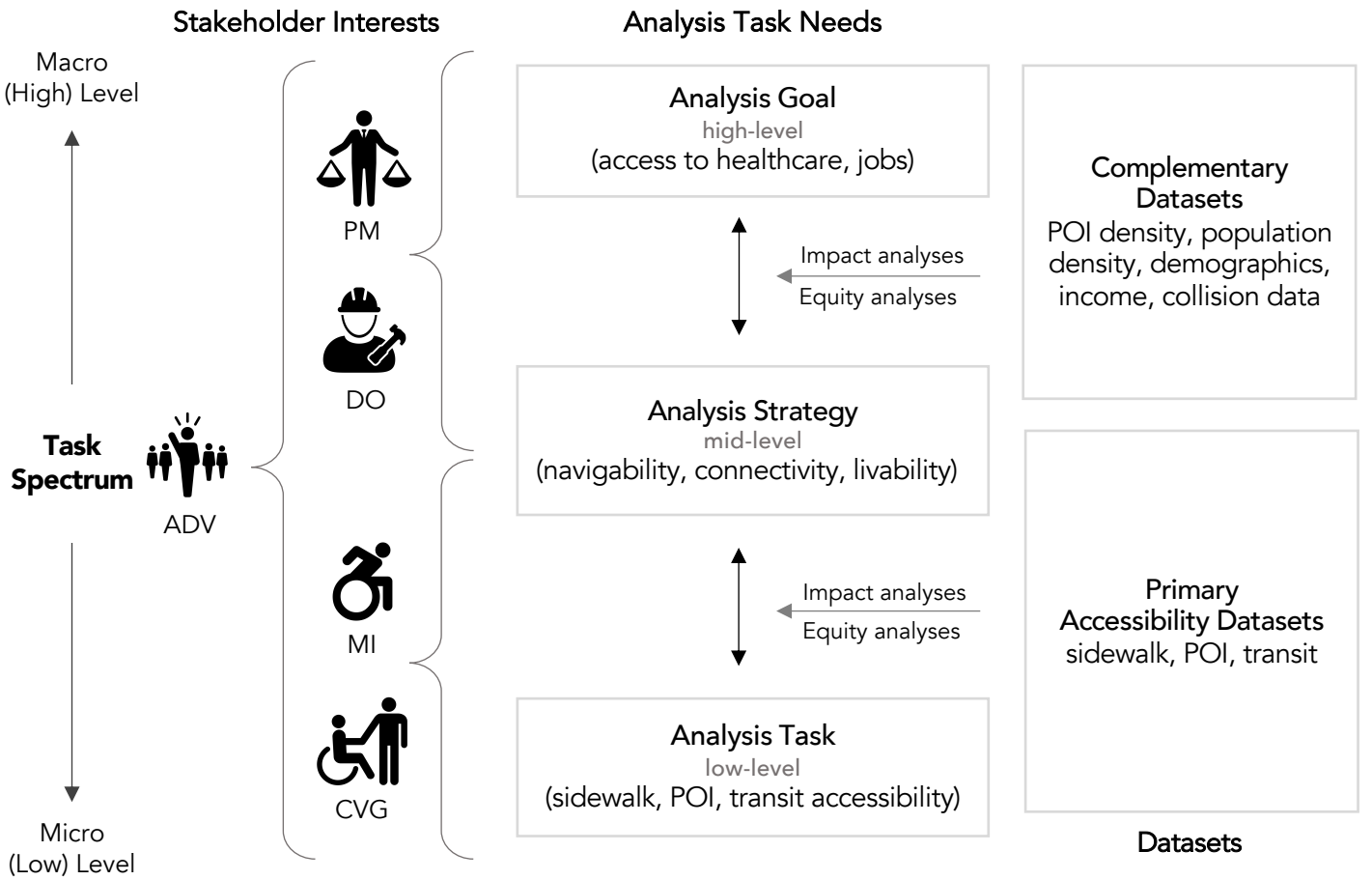

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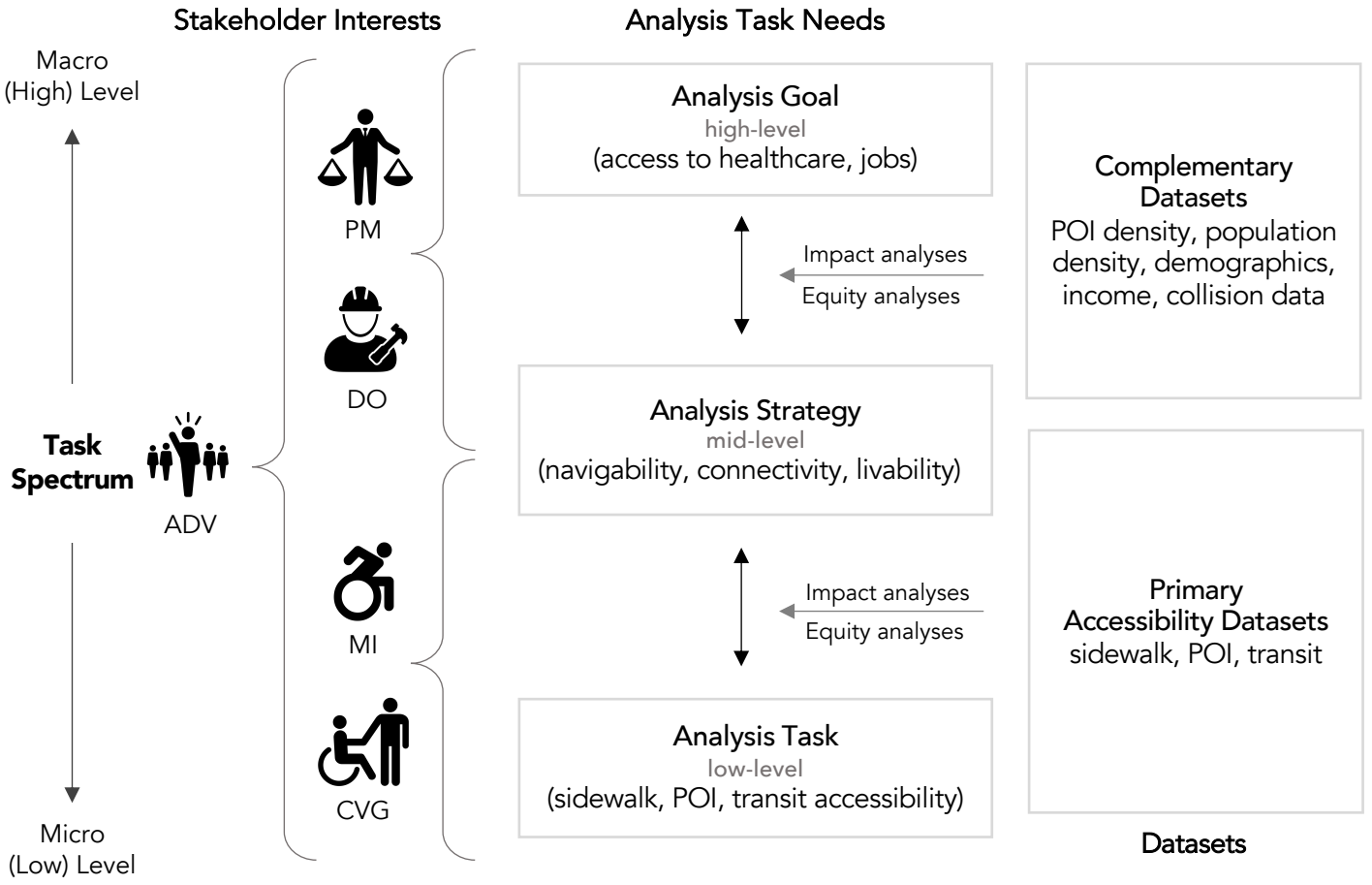

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FINDINGS: CATEGORIES

Key
Data + Task Needs
RQ1

Sensemaking
practices and differences
RQ2

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Sensemaking
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RQ2

RQ2: HOW DO KEY STAKEHOLDERS' SENSEMAKING PRACTICES DIFFER?

Personal experiences drove sensemaking

Contextualizing patterns is a core sub-task

Personally relevant assessment factors influenced metrics used

Supporting diverse accessibility needs is key

Stakeholders' decision context influenced map choices

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Map Familiarity

Accessibility Advocate

Street Vis

> *What I'm looking for here [StreetVis] is not just redness, but the distribution of redness across a particular area as it connects to other red markings*

P7AC, an advocate analyzing connectivity

RQ2: HOW DO KEY STAKEHOLDERS' SENSEMAKING PRACTICES DIFFER?

Personal experiences drove sensemaking

Accessibility Familiarity

Location Familiarity

Map Familiarity

Department Officials

Street Vis

Map's utility depended on the alignment with a user's mental models

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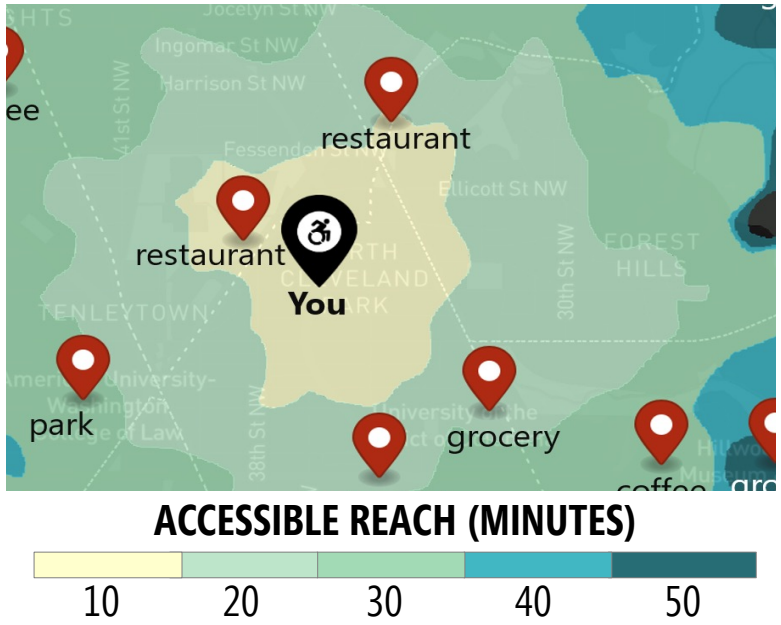
MI Individuals Caregivers

Isochrones



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FINDINGS: CATEGORIES

Key Data + Task Needs

RQ1

How do we handle the **diverse assessment factors** needed across **varied decision-making contexts** for urban accessibility?

Sensemaking practices and differences

RQ2

How did **individual differences** in stakeholders' needs and experiences **impact sensemaking processes**?

FINDINGS: CATEGORIES

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RQ1

How do we handle the **diverse assessment factors** needed across **varied decision-making contexts** for urban accessibility?

Sensemaking practices and differences

RQ2

How did **individual differences** in stakeholders' needs and experiences **impact sensemaking processes**?

Given these challenges, how might we **utilize interactive visualizations** to support **communication and decision-making needs** for urban accessibility?

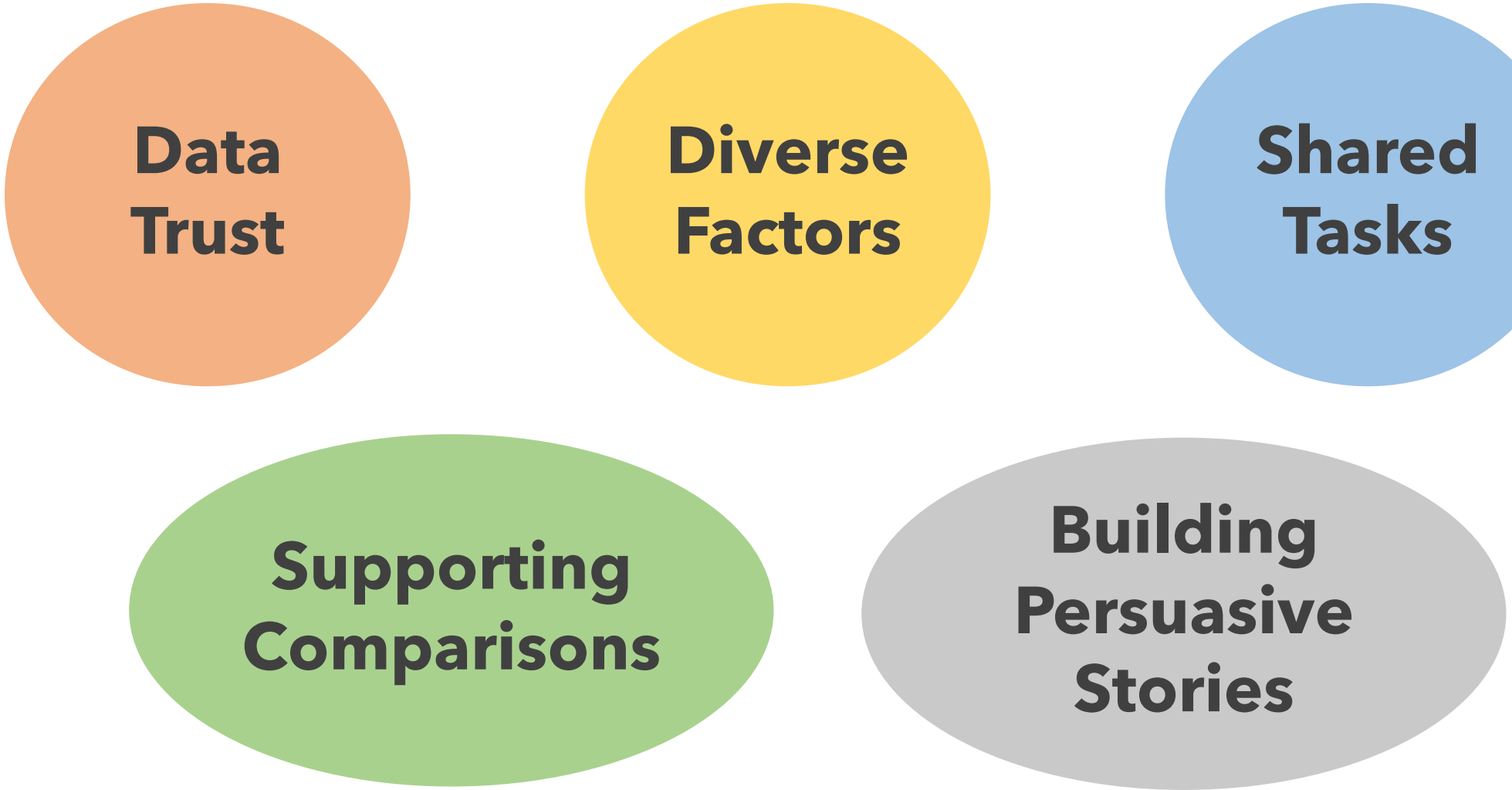
DISCUSSION: VISUALIZING URBAN ACCESSIBILITY

DESIGN CONSIDERATIONS FOR INTERACTIVE VISUALIZATION TOOLS

	Design Considerations (C)	Example Application of Design Considerations
Establishing Data Trust	C1: Make clear where the data comes from (Data Provenance)	Document data sources and collection information
	C2: Make clear how data is modeled (Analytic Provenance)	Provide explanation of the algorithms/models used
Handling Diverse Assessment Factors	C3: Support for adding diverse datasets	Advocates can add their personally collected data in their desired format (e.g., Excel, CSV)
	C4: Support multivariate analysis: both analyzing across accessibility assessment factors and visualizing diverse datasets	Policymakers assess the impact of inaccessible infrastructure on MI individuals to reveal inequities
Supporting Shared Stakeholder Tasks	C5: Support for varied, often conflicting, stakeholder group needs	MI/Caregivers assess navigability of a neighborhood Department officials assess equity in distribution and prioritization of resources and investments
	C6: Support for individual differences (e.g., familiarity with maps, accessibility, location)	MI/Caregivers' view tailored to localized data and neighborhood and street level maps (e.g., Isochrones)
	C7: Support for adjusting to visualization user needs as an analyst or target consumer	
Supporting Comparisons	C8: Make it easy to compare between multiple data, map, and geo-contextual views (e.g., providing historical context on accessibility investments across locations)	Department officials comparing accessibility of multiple locations within and across cities
Building Persuasive Stories	C9: Support for audience-driven message framing by adding relevant contextual data	Framing for policymakers: show impact of investments on citizen's quality of life Framing for MI/Caregivers: show impact of inaccessibility on their personal life
	C10: Support for exporting audience-driven stories in multiple visualization formats	

DISCUSSION: VISUALIZING URBAN ACCESSIBILITY

DESIGN CONSIDERATIONS



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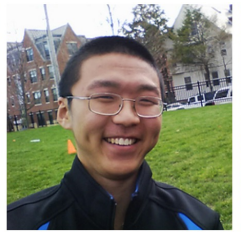

Anthony Li

Students

makeabilitylab.io

https://makeabilitylab.cs.washington.edu/people/

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Center for Research and Education on Accessible Technology and Experiences

UNIVERSITY of WASHINGTON

Visualizing Urban Accessibility

Investigating Multi-Stakeholder Perspectives through a Map-based Design Probe Study

On the job market!
Industry research

Any Questions?

Key Theme

Socio-political and personal nature of urban accessibility influenced how stakeholders **understand** and **use** visualizations

Accessibility **Location** **Map/Data Analysis Skills**

Key Findings

Personally relevant assessment metrics were used during sensemaking

Maps complying with personal mental models of accessibility were preferred

Relevance to individual decision-making context was a key determinant

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MAKEABILITY LAB

DESIGN USE BUILD

PAUL G. ALLEN SCHOOL OF COMPUTER SCIENCE & ENGINEERING

UNIVERSITY of WASHINGTON