

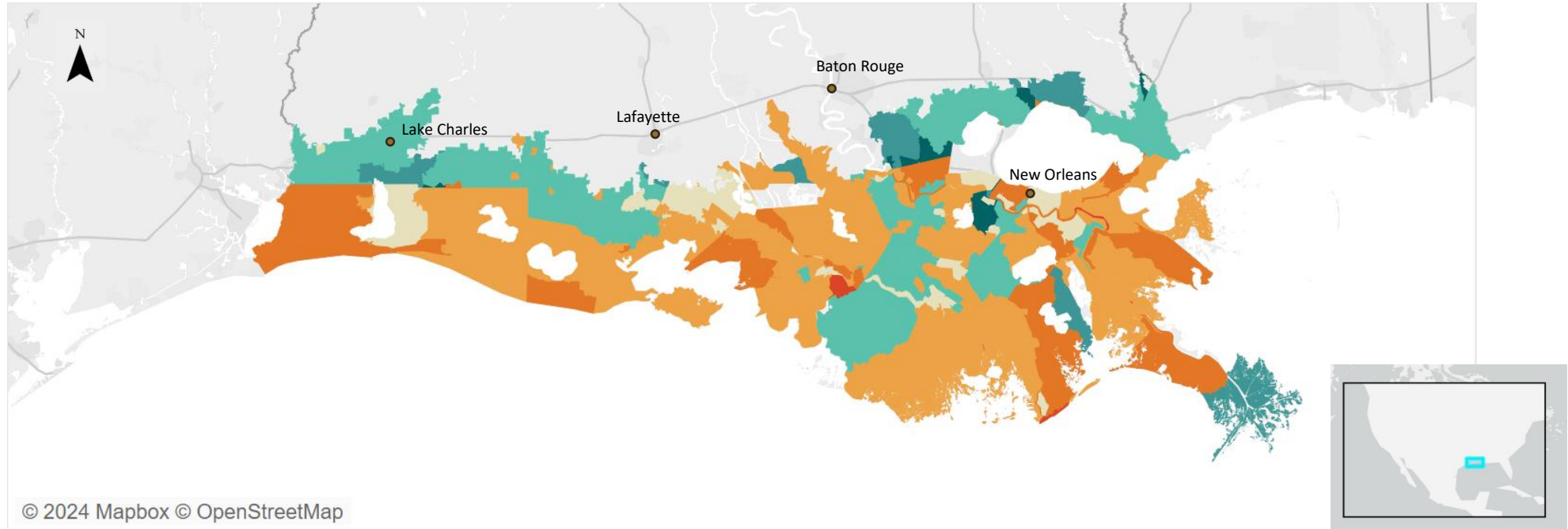
USING EQUITABLE ACCESS TO ESSENTIAL SERVICES AS GUIDANCE FOR INVESTMENTS IN COASTAL ADAPTATION

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Population is declining in coastal Louisiana



Percent Population Change 2000-2020



Population decline and increasing flood risk are causing disruptions to essential services

What are the impacts of disruptions to essential services?

- Flood risk is increasing in most coastal communities
- Population decline in rural areas also contributes to closures



How convenient are alternatives if a household's best option is shut down?



Image Source: (Bittle, 2023)

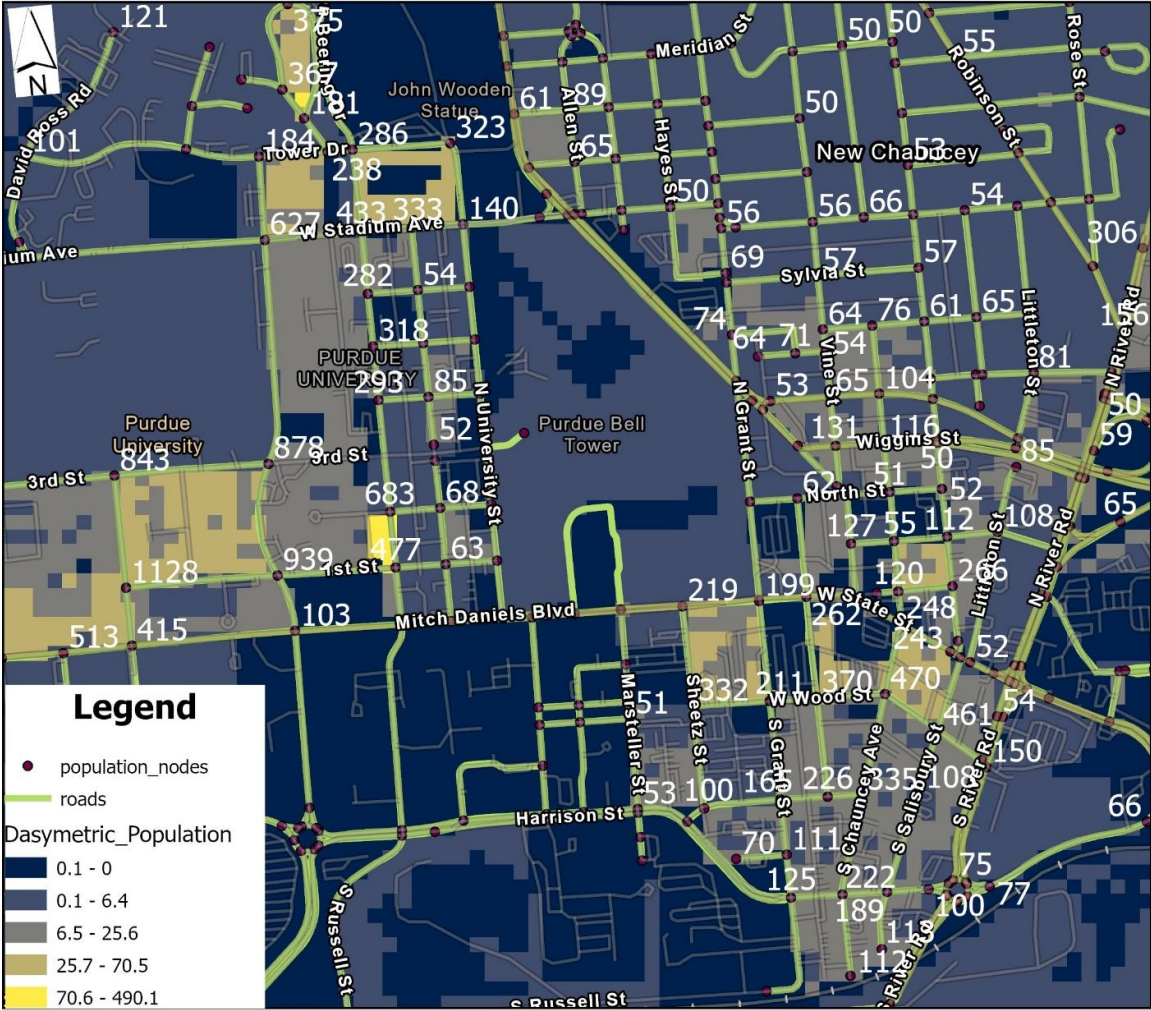
Research Questions

1. *How can measures of accessibility to critical and essential services be modified to capture access fragility in communities?*
2. *How do decision-maker priorities shape what is considered critical, and how can robust solutions be identified under preference heterogeneity?*

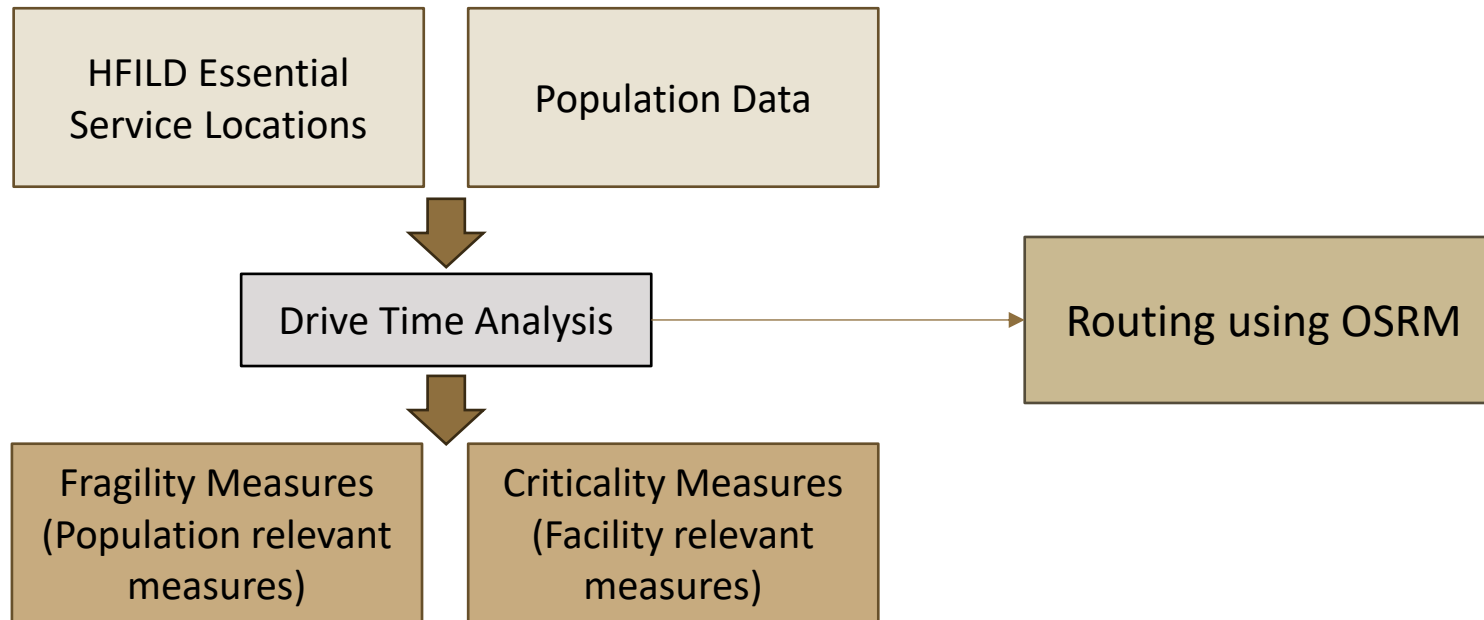
Coarse centroids obscure fine-scale accessibility differences

OpenSteetMap

Population Centroids (Dasymetric Populations)

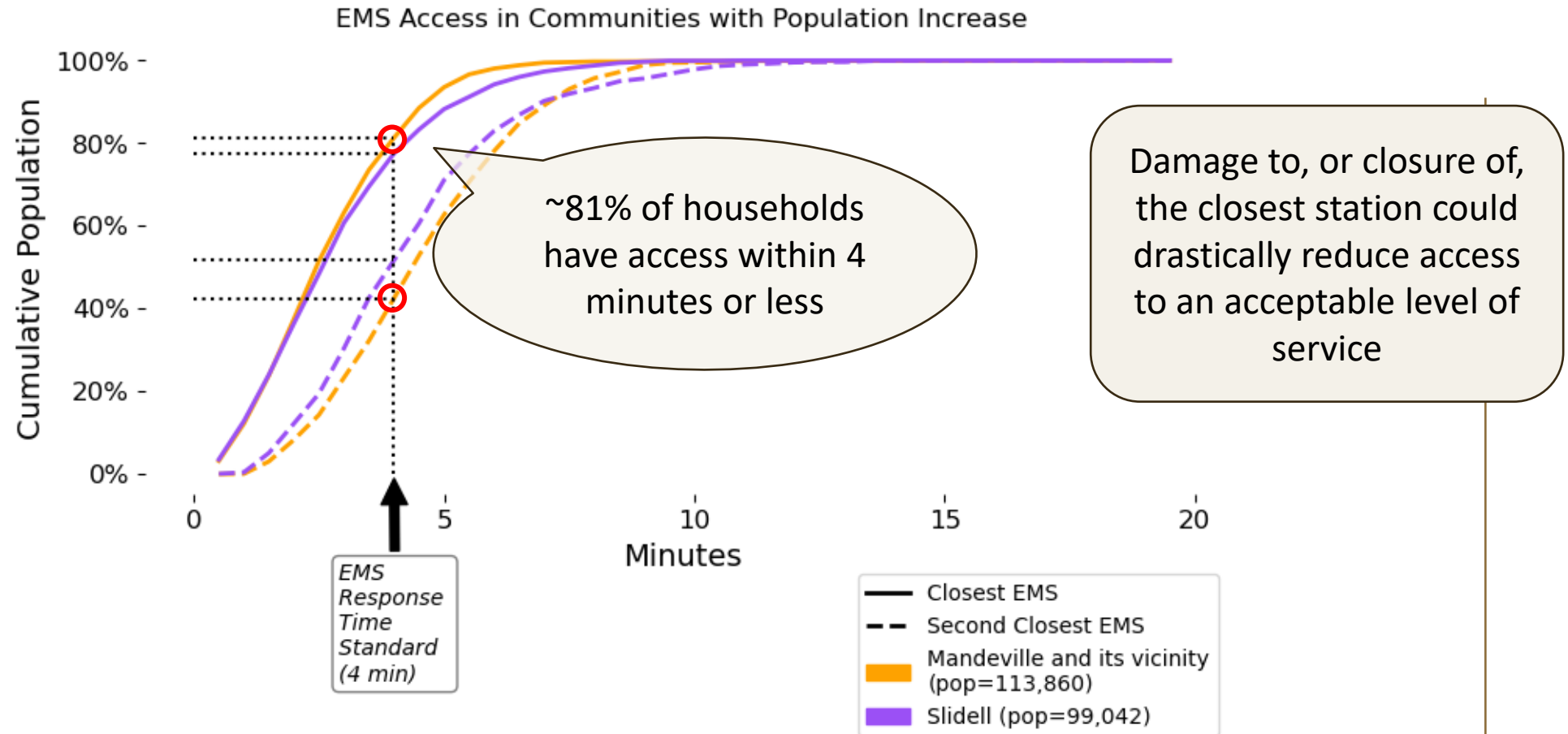


The overall framework integrating public data sources and tools



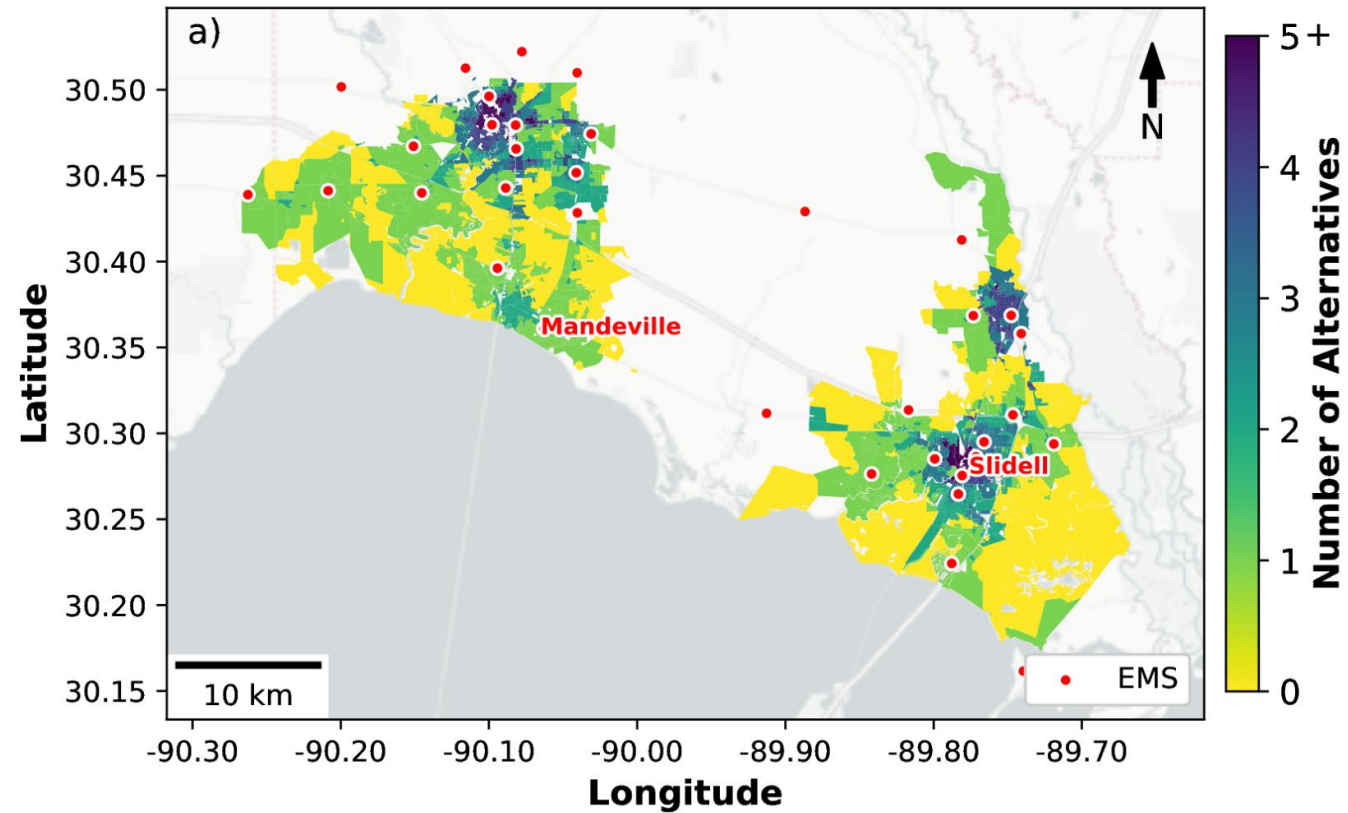
- Drive time to closest location
- Marginal drive time between first and second closest location
- Number of alternative locations within critical time threshold
- Total population served as primary provider
- Primary population percentage with no other alternative under critical time threshold
- Weighted average of marginal travel time for primary population with no other alternative under critical time threshold

Cumulative distribution functions of access tell us about access fragility



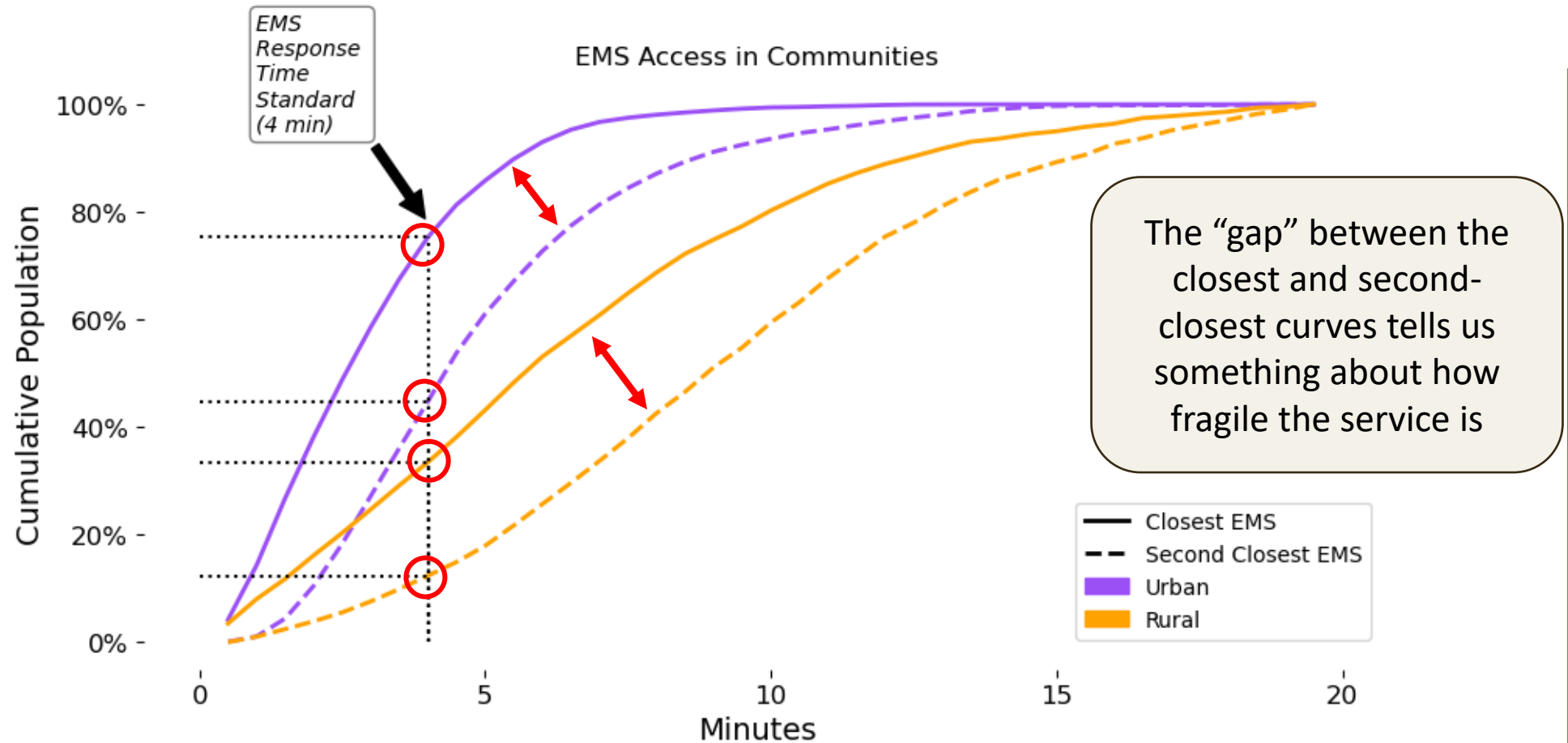
Cumulative population graph of drive time to closest and second closest EMS stations

Access robustness is spatially heterogeneous



Number of EMS stations within a 4-minute critical time threshold

Urban and rural Louisiana have stark differences in access



What makes an asset more or less critical to a community?

Planners may have different views on what is most important

- How many people are served by this facility?
- How many of those people have no suitable alternative?
- For those with no suitable alternative, just how bad is the next best option?

What makes an asset more or less critical to a community?

Planners may have different views on what is most important

- Total population served as primary provider
- Percentage of primary population with no other alternative within a critical time threshold for service
- Weighted average of marginal travel time for primary population with no other alternative under critical time threshold

Robustness analysis helps us answer this question

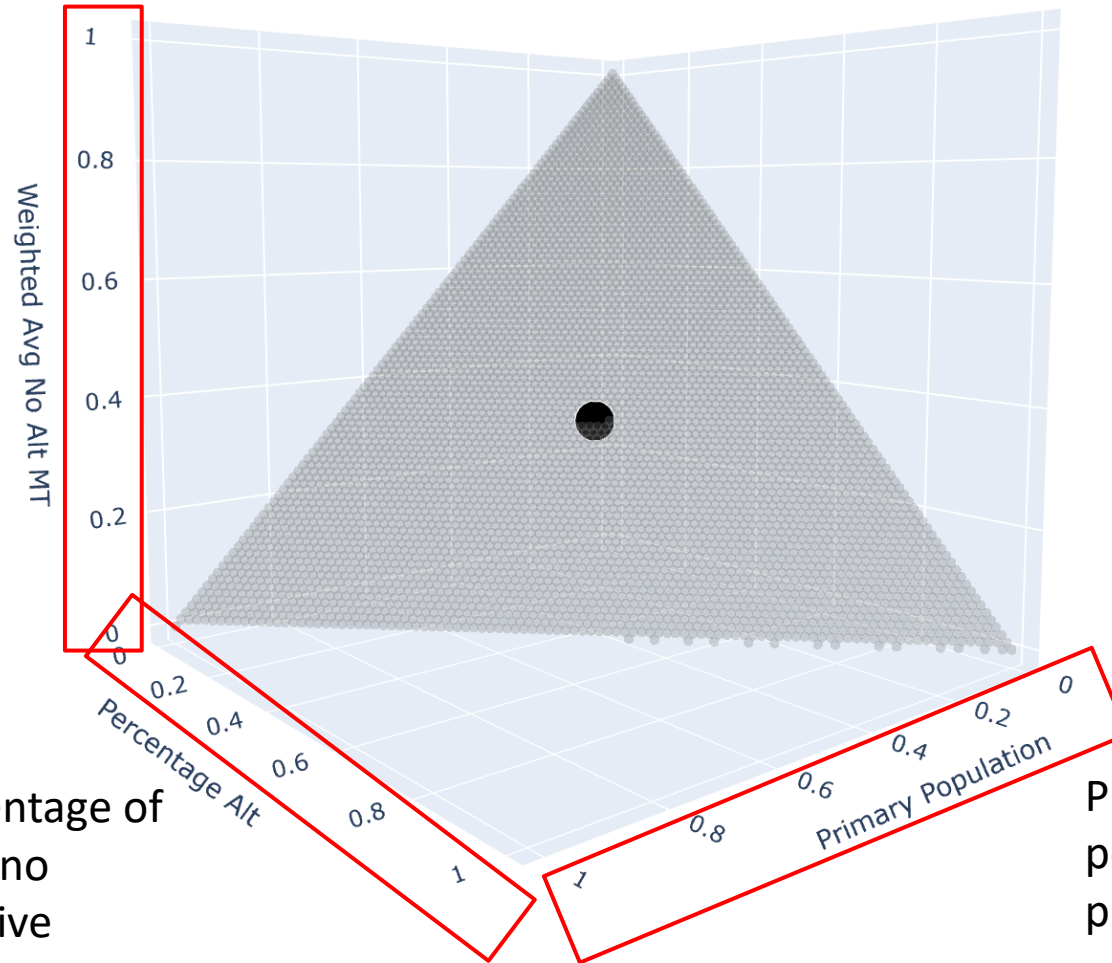
- Normalize all three measures
- Create a large combination space of priority weights
- $Criticality = w_1 * P + w_2 * A + w_3 * M$
- w_1, w_2, w_3 : Weights assigned to each variable, which must sum to 1 ($w_1 + w_2 + w_3 = 1$)
- P : Primary population served by the facility
- A : Primary population percentage without an alternative
- M : Weighted average of marginal travel time for primary population with no other alternative under critical time threshold
- Rank all facilities within their type between 1-5 based on their criticality score (higher = more critical)
 - We care about rank stability of facilities in determining criticality → facilities that constantly appear in top 5 are critical

How robust are rankings of criticality to different priorities?

Priority on marginal travel time for primary population with no suitable alternative

Priority on percentage of population with no suitable alternative

Priority on total population served as primary provider

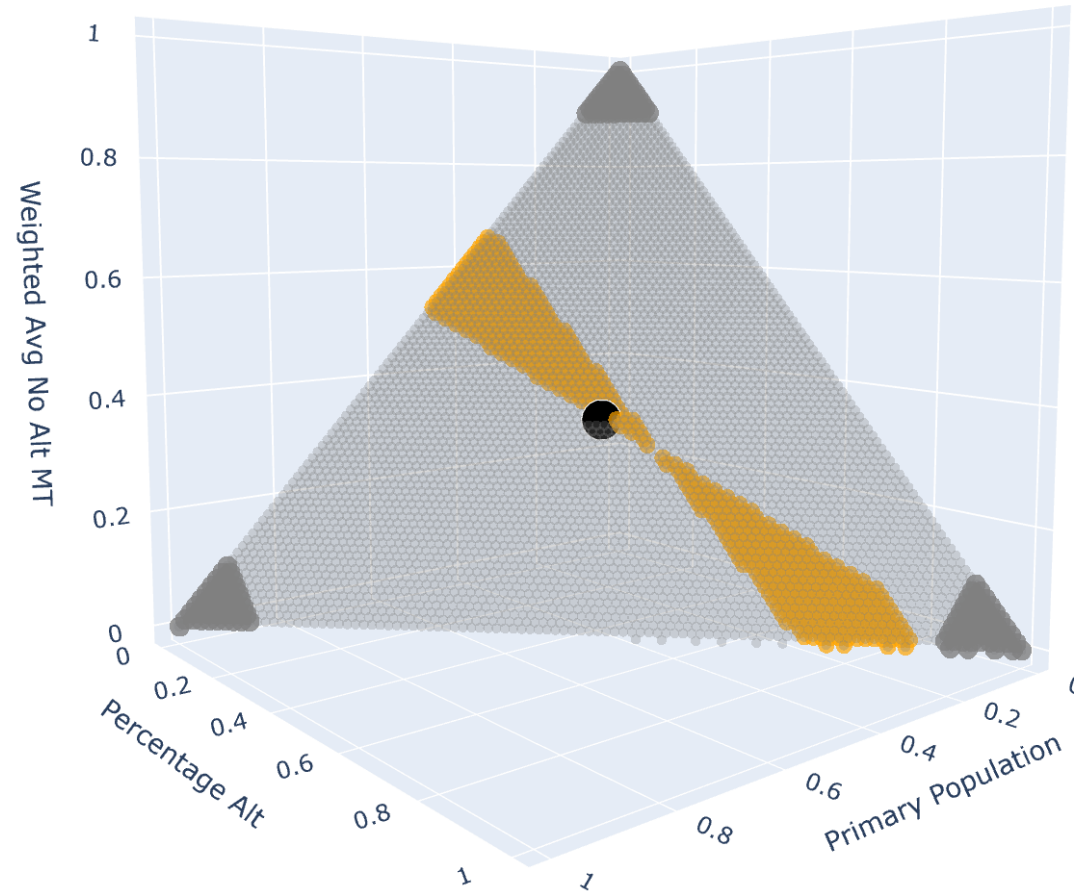


How to read results from robustness analysis?

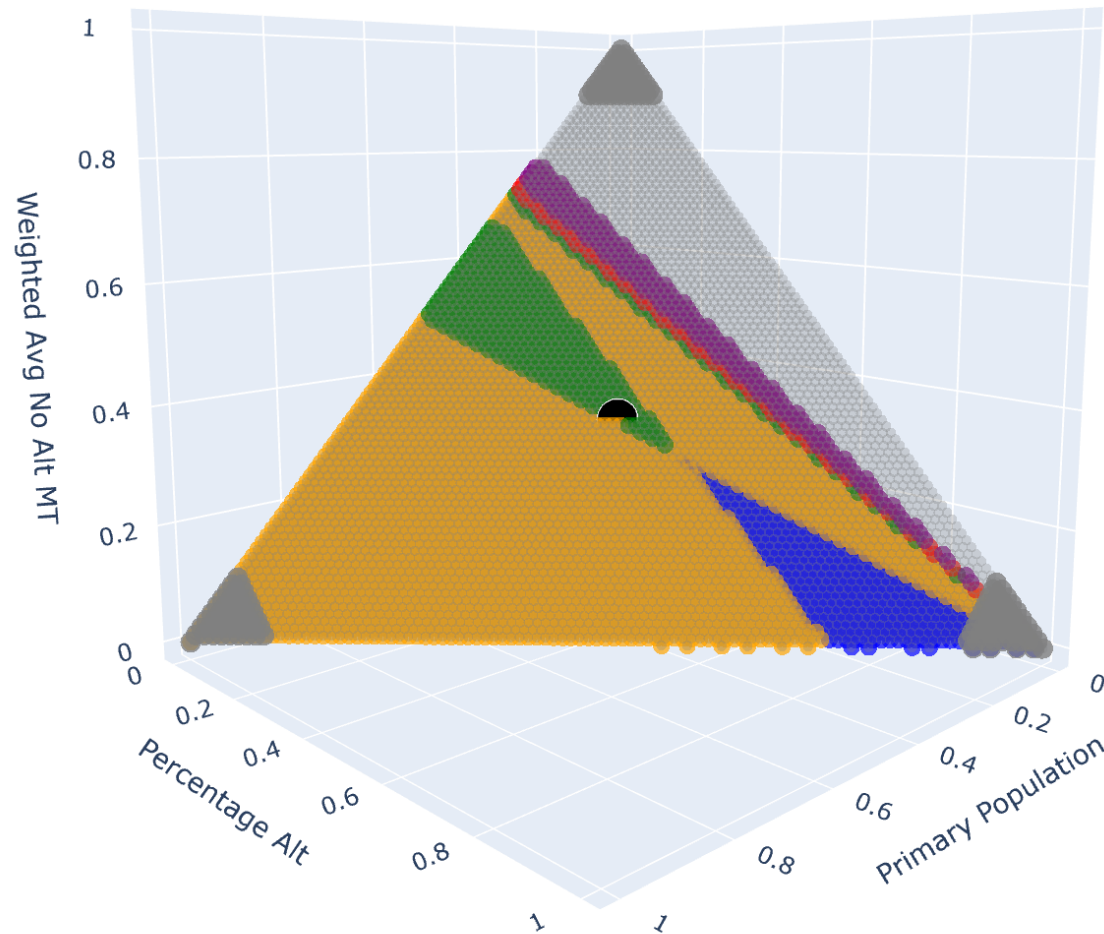
Row Rank	Facility Name	Primary Population	Percentage without Alternative	Weighted Avg Marginal Time (No Alt)	Rank 1%	Rank 2%	Rank 3%	Rank 4%	Rank 5%	Total Percentage	Equal Weight Rank
1	NEW ORLEANS LAKEFRONT AIRPORT AIRCRAFT RESCUE ...	103195	100.00	5.53	6.67	55.88	8.56	1.83	3.79	76.72	3.0
2	PLAQUEMINES PARISH AMBULANCE DEPARTMENT - WOOD...	374	100.00	32.39	50.28	2.17	4.89	13.05	4.47	74.87	2.0
3	NEW ORLEANS EMERGENCY MEDICAL SERVICES	125109	94.19	2.67	43.03	11.20	10.53	1.35	1.37	67.48	1.0
4	EASTBANK CONSOLIDATED FIRE DEPARTMENT STATION 17	92471	97.70	3.17	0.00	0.58	42.81	18.02	1.03	62.44	4.0
5	CAMERON PARISH EMERGENCY MEDICAL SERVICES - GR...	312	100.00	16.50	0.00	30.10	4.21	4.55	13.11	51.97	NaN

This shows, percentage of combination space each facility appears in each rank within its facility type. For instance, New Orleans Emergency Medical Services is ranked 2 most critical among all schools 11.2% of the weight combination space.

How to read results from robustness analysis?



Some assets may be critical over a wide range of preferences



- Rank 1
- Rank 2
- Rank 3
- Rank 4
- Rank 5
- Equal Weights Point
- Extreme Scenarios

Example: New Orleans Lakefront Airport Rescue and Fire Station

Policy implications of modifying access to essential and critical services to better represent access fragility

- Redundancy in access can lead to more resilient communities.
 - In rural areas the lack of alternatives is becoming more apparent as different essential services are closing due to decreased demand
- Preferred actions may be fairly robust to divergent priorities
 - In other words, even if we disagree on what is most important, we may agree on the right course of action

Evaluating critical and essential service access vulnerabilities

LETTER • OPEN ACCESS

Evaluating critical and essential service access vulnerabilities

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THANK YOU!

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