

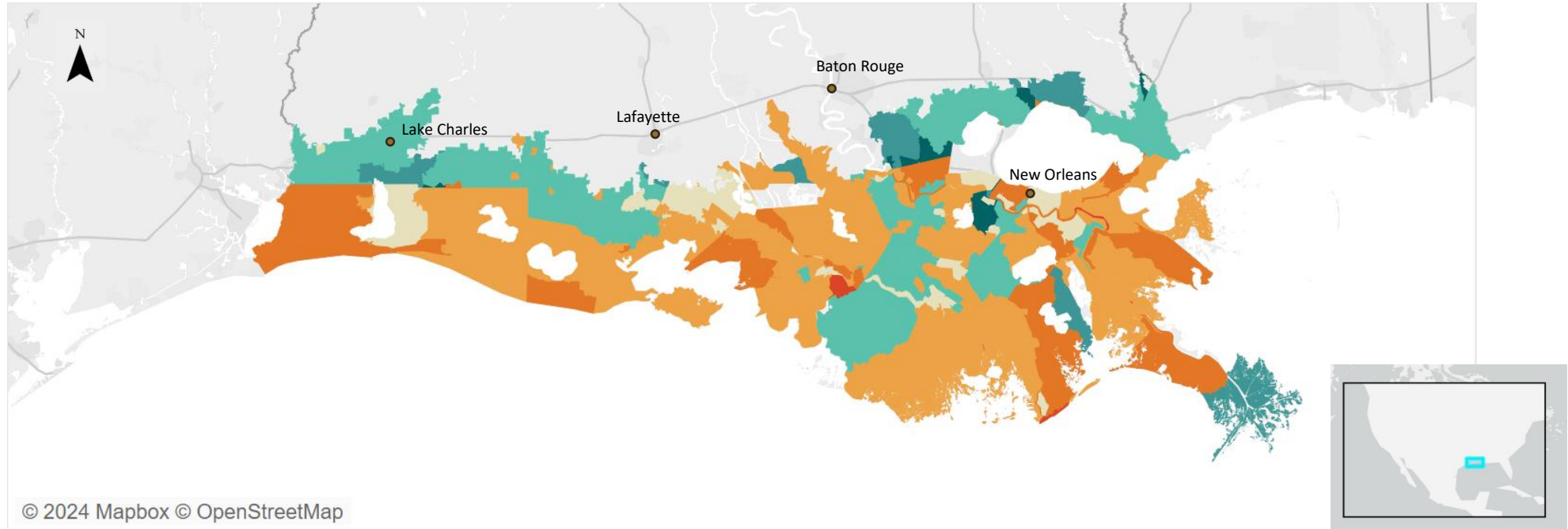
USING EQUITABLE ACCESS TO ESSENTIAL SERVICES AS GUIDANCE FOR INVESTMENTS IN COASTAL ADAPTATION

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Population is Declining in Coastal Louisiana



Percent Population Change 2000-2020

100% loss

50 to 100% loss

5 to 50% loss

5% loss to 5% gain

5 to 50% gain

50 to 100% gain

More than 100% gain

Measures of Risk Based On Capabilities

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

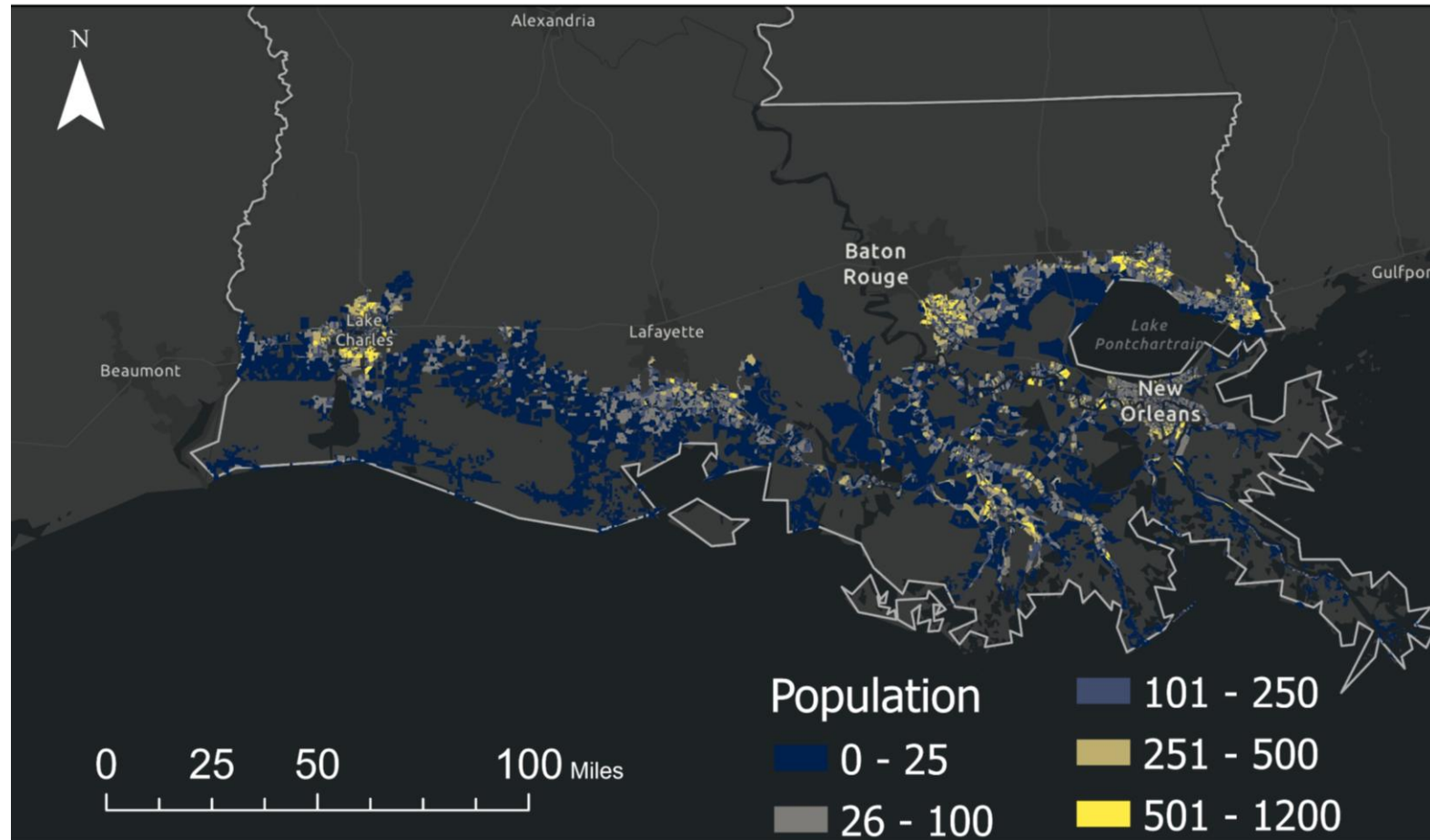


How convenient are alternatives if a household's best option is shut down?



Image Source: (Bittle, 2023)

Empirical Setting – CLARA Cells with Population

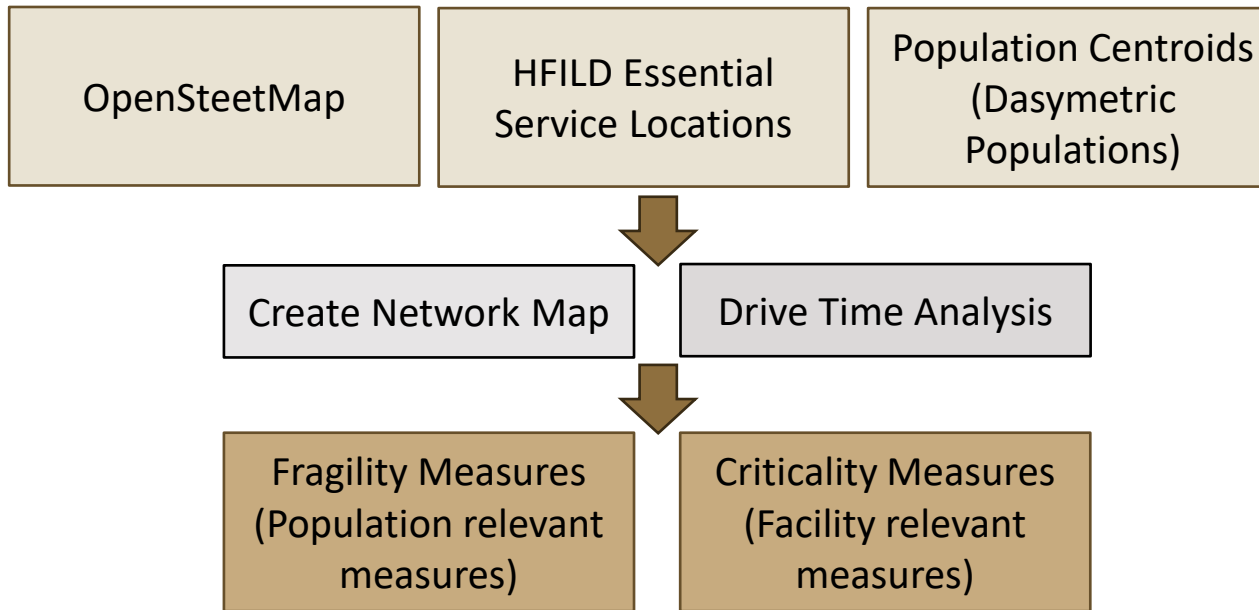


Empirical Setting Communities in Louisiana - Communities with population in Coastal Louisiana Risk Assessment (CLARA)

Research Questions

1. *How to quantify the fragility of the access to essential services using transportation networks as it relates to resilience?*
2. *How can we evaluate the critical importance of an essential service facility using drive-time analysis?*
3. *How will decision-makers' preferences regarding a criticality measure affect which facility is prioritized for protection?*

Methods: Overall Framework



- 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

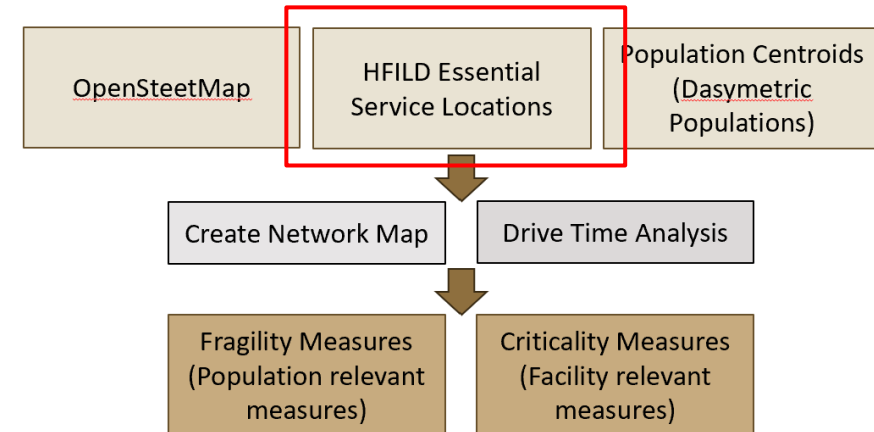
Policy Recommendations

Methods: Fragility

How to quantify the fragility of the access to essential services using transportation networks as it relates to resilience?

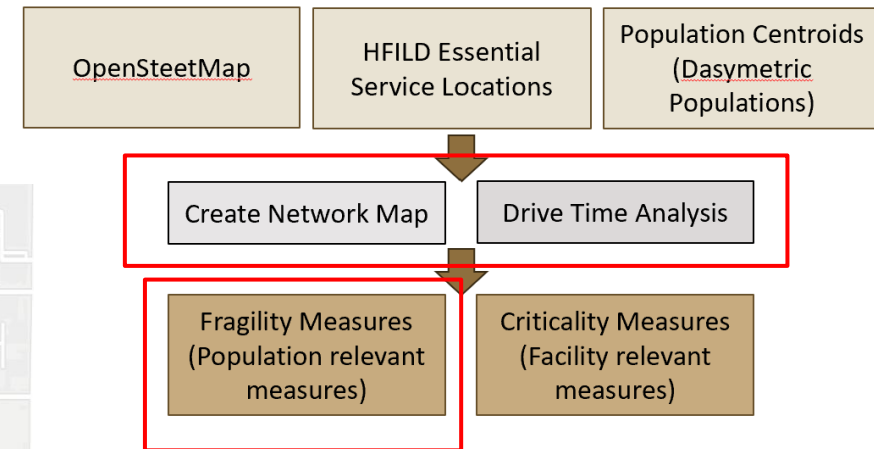
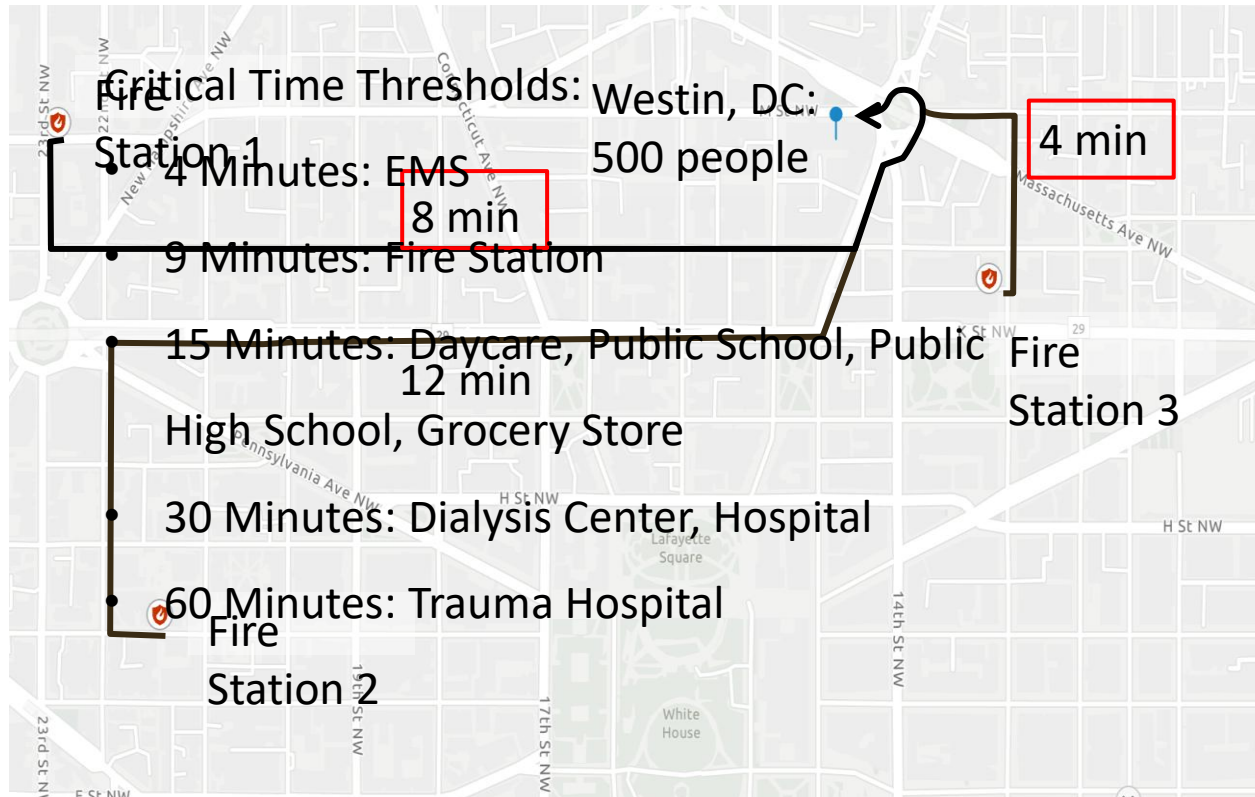
■ Essential Services:

- Emergency Medical Service (EMS)
- Fire Station
- Daycare
- Public School (Kindergarten, Elementary, Middle, Junior High)
- Public School (High School)
- Dialysis Center
- Hospital
- Trauma Hospital
- Grocery Store



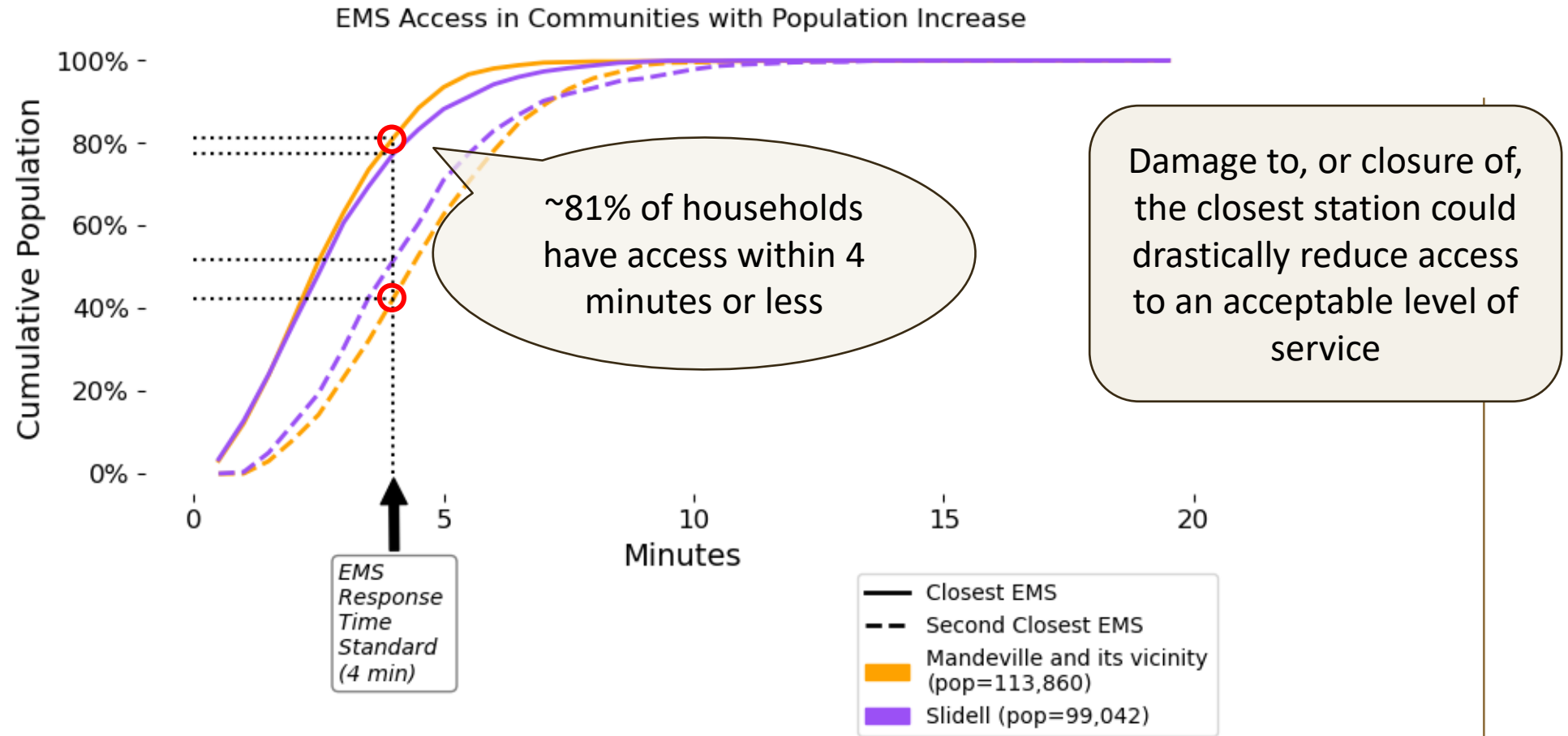
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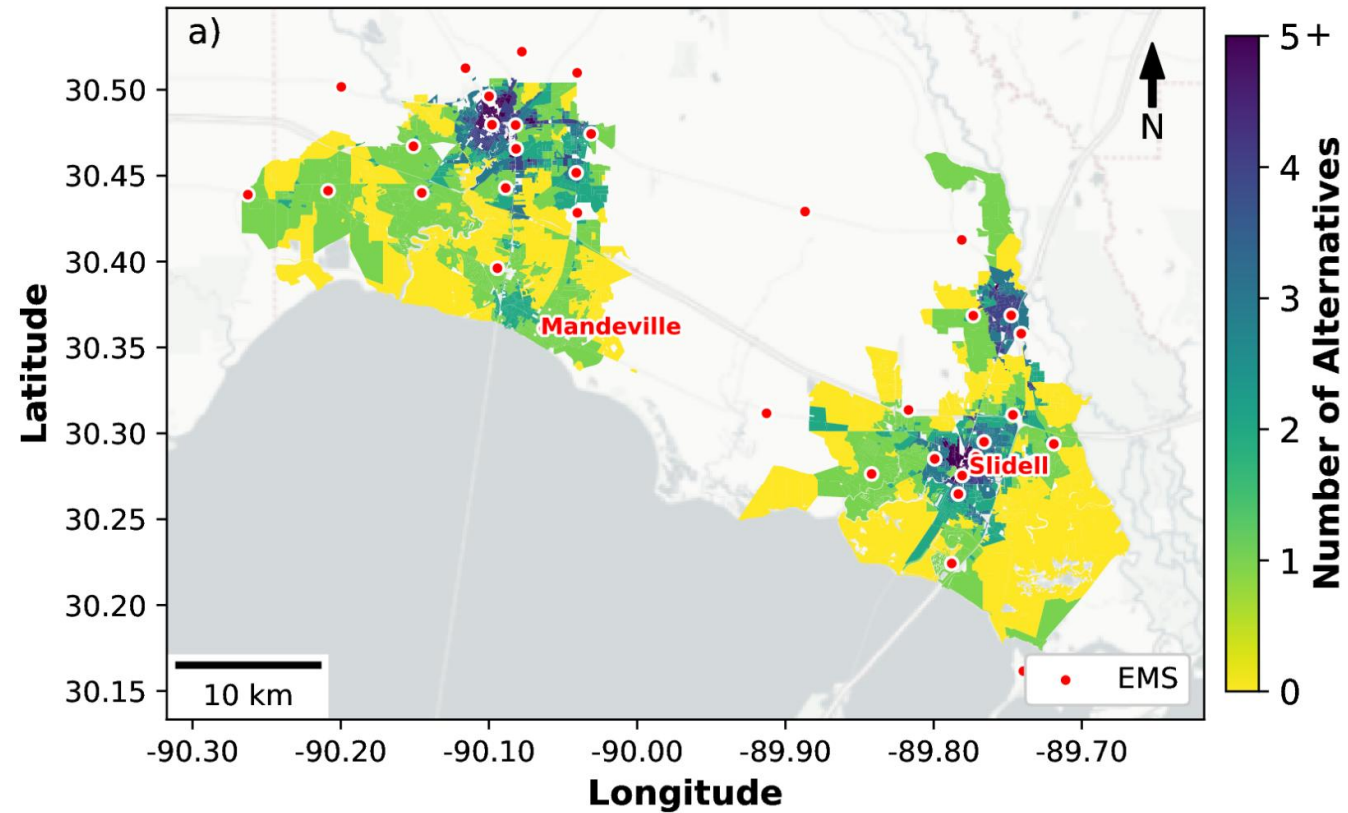
- Drive time to closest location
- Marginal drive time between first and second closest location
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Access to Emergency Medical Services (EMS) Stations



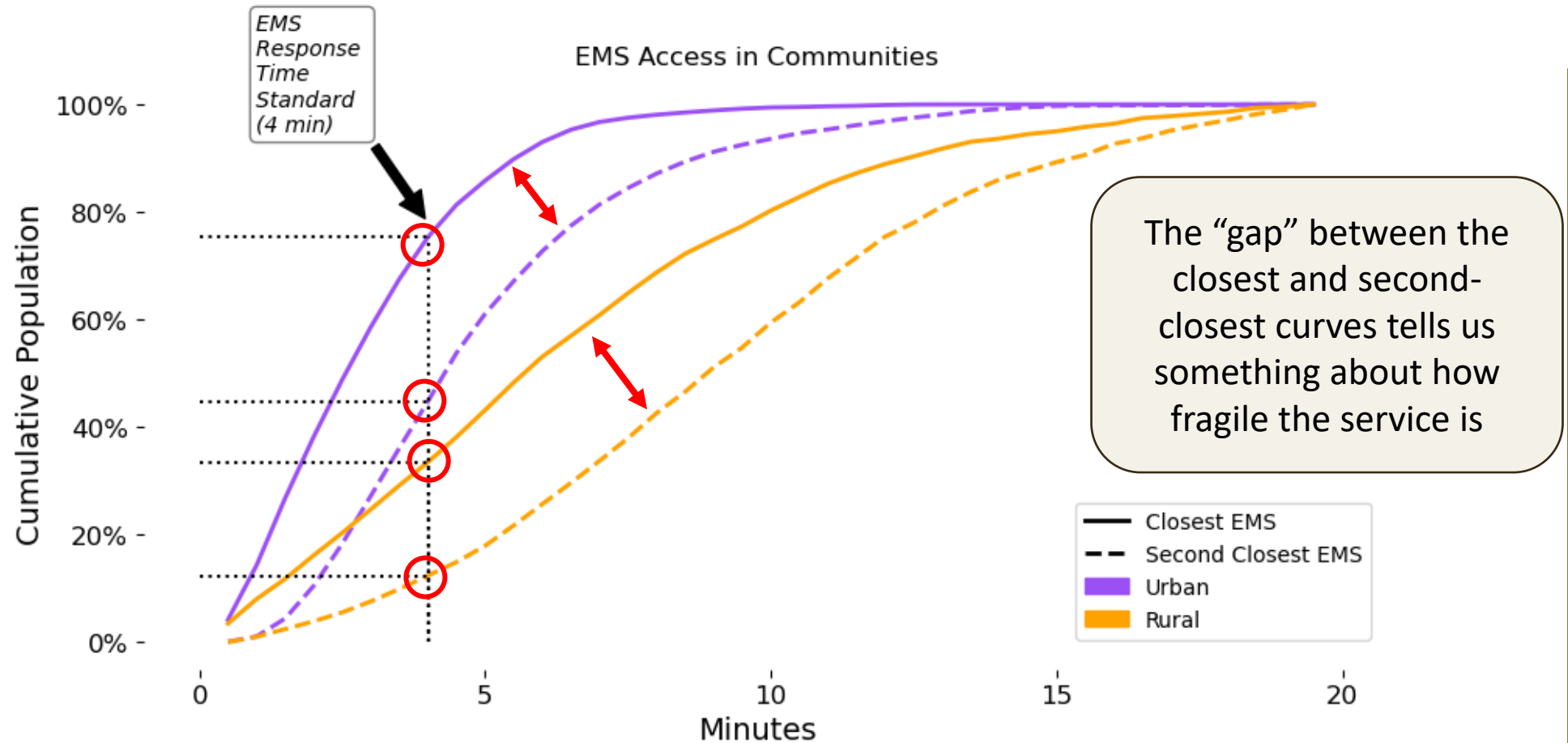
Cumulative population graph of drive time to closest and second closest EMS stations

Access to Emergency Medical Services (EMS) Stations



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

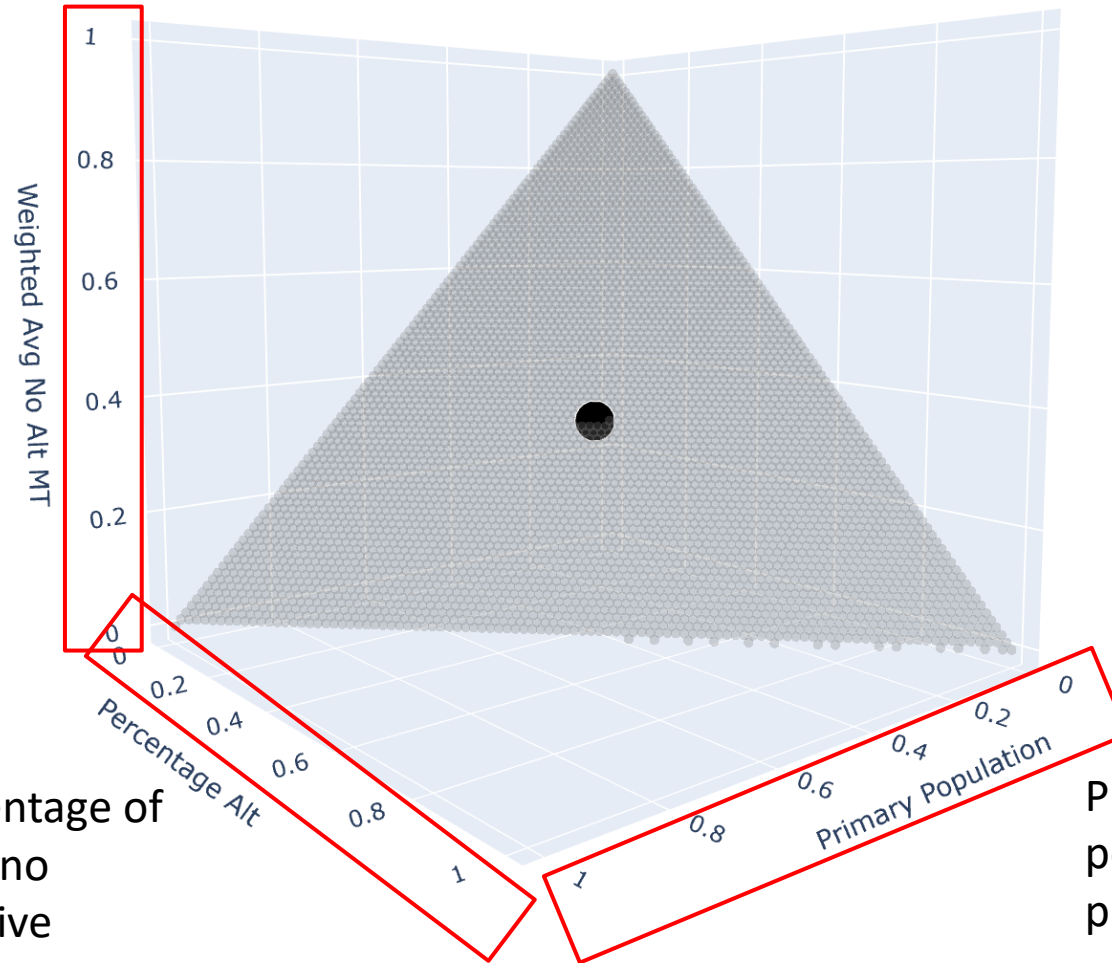
- Total population served as primary provider
- Percentage of primary population with no other alternative within a critical time threshold for service
- Weighted average of marginal travel time for primary population with no other alternative under critical time threshold

Methods and Analysis

- 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

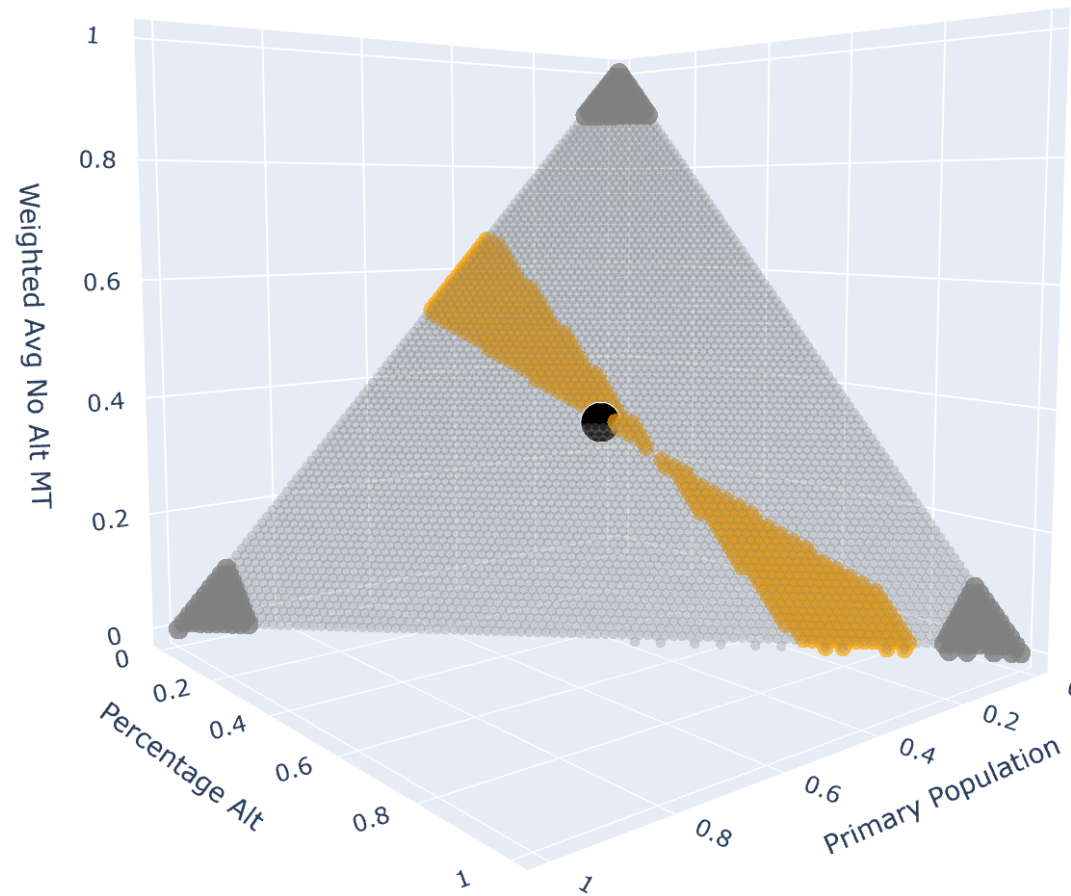
Priority on total population served as primary provider

Criticality – Most Critical EMS Facilities

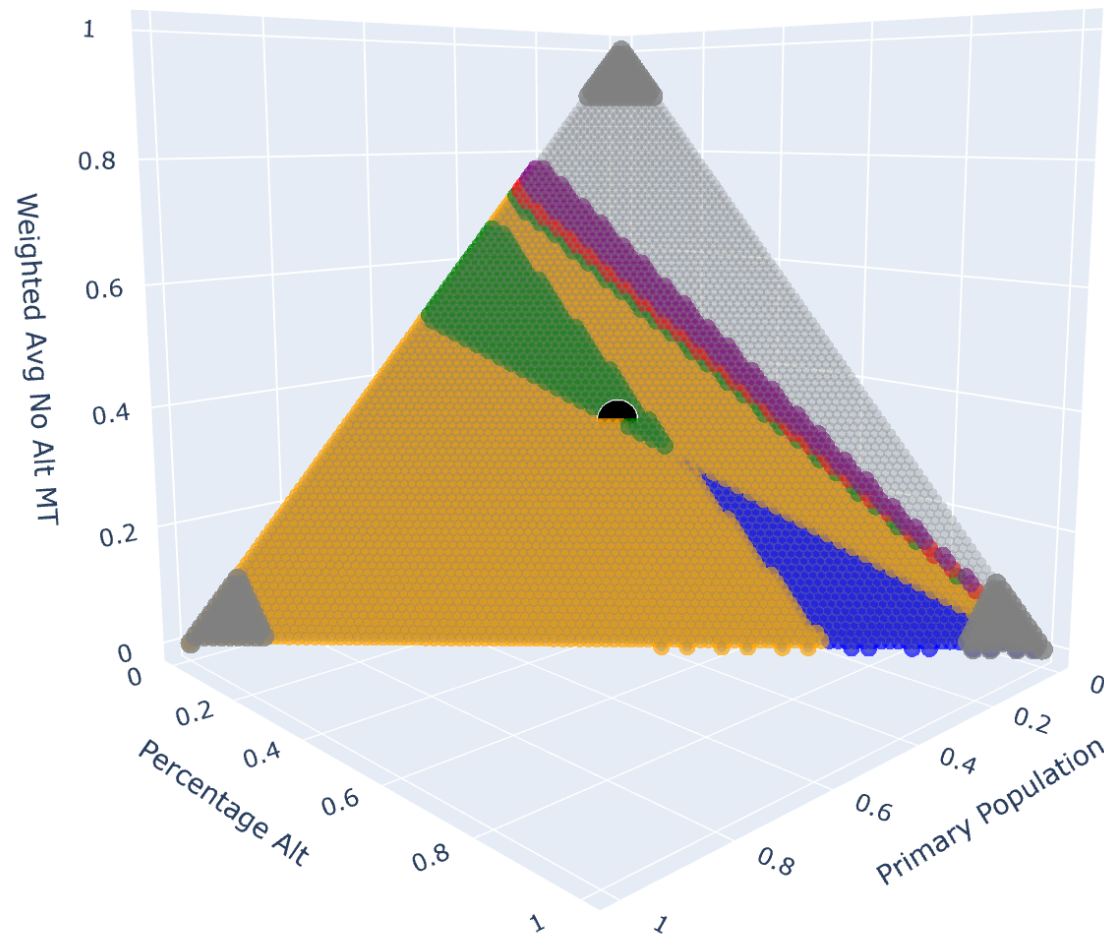
Row Rank	Facility Name	Primary Population	Percentage without Alternative	Weighted Avg Marginal Time (No Alt)	Rank 1%	Rank 2%	Rank 3%	Rank 4%	Rank 5%	Total Percentage	Equal Weight Rank
1	NEW ORLEANS LAKEFRONT AIRPORT AIRCRAFT RESCUE ...	103195	100.00	5.53	6.67	55.88	8.56	1.83	3.79	76.72	3.0
2	PLAQUEMINES 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.

Criticality – Most Critical EMS Facilities



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

- 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!

For questions and to connect: ugenc@purdue.edu