

Urban Vegetation Change and Its Impact on Housing Prices: A Pre- and Post-COVID19 Pandemic Analysis

Dasom Han April. 2024

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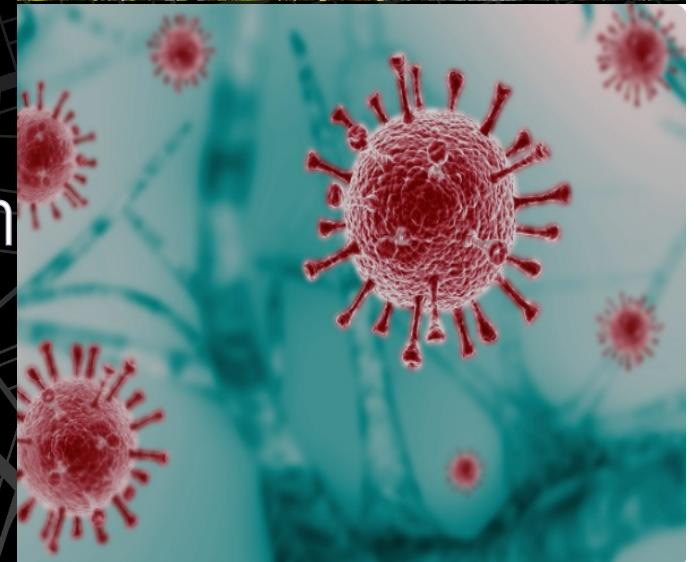
ABOUT THE PROJECT

01

About the Project

Factors Affecting Housing Prices

Policy Change Crime
Housing Structure Infection
Supply & Demand Vegetation Change
Surrounding Environment segregation
Population Density





02

LITERATURE REVIEW

Literature Review

Findings

Authors

Found that urban green spaces enhance local air quality and property values.

Jim & Chen
(2006)

Proximity to green spaces significantly increases housing prices due to psychological and recreational benefits.

Tyrväinen and Miettinen (2000)

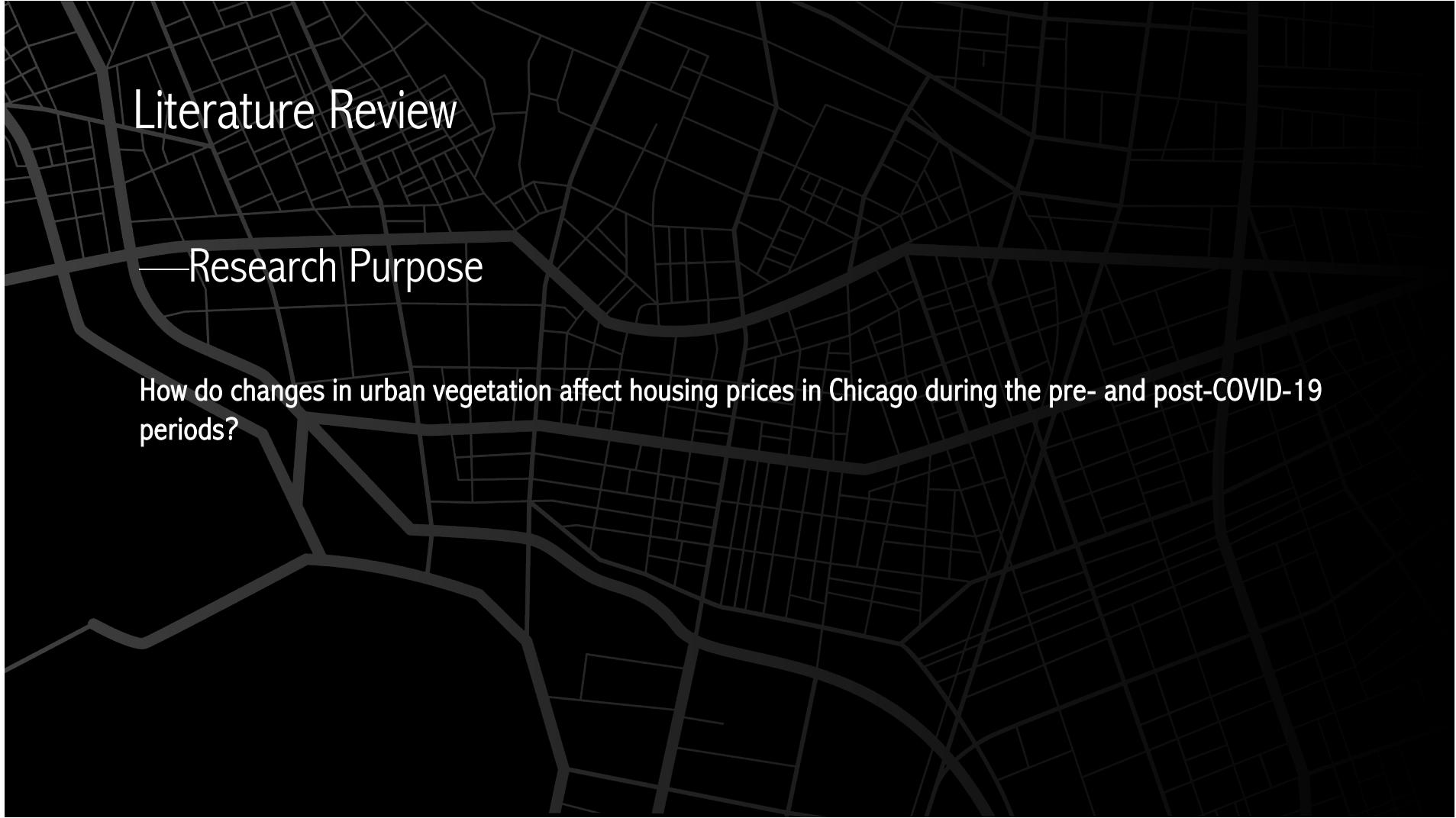
Quality of green spaces is crucial, with high-quality areas commanding a significant premium.

Panduro and Veie (2013)

Literature Review

Relevance to Current Challenges

1. The COVID-19 pandemic has altered preferences towards living environments, emphasizing the importance of quality urban greenery.
2. Insights help urban planners make informed decisions in line with contemporary needs.



Literature Review

Research Purpose

How do changes in urban vegetation affect housing prices in Chicago during the pre- and post-COVID-19 periods?

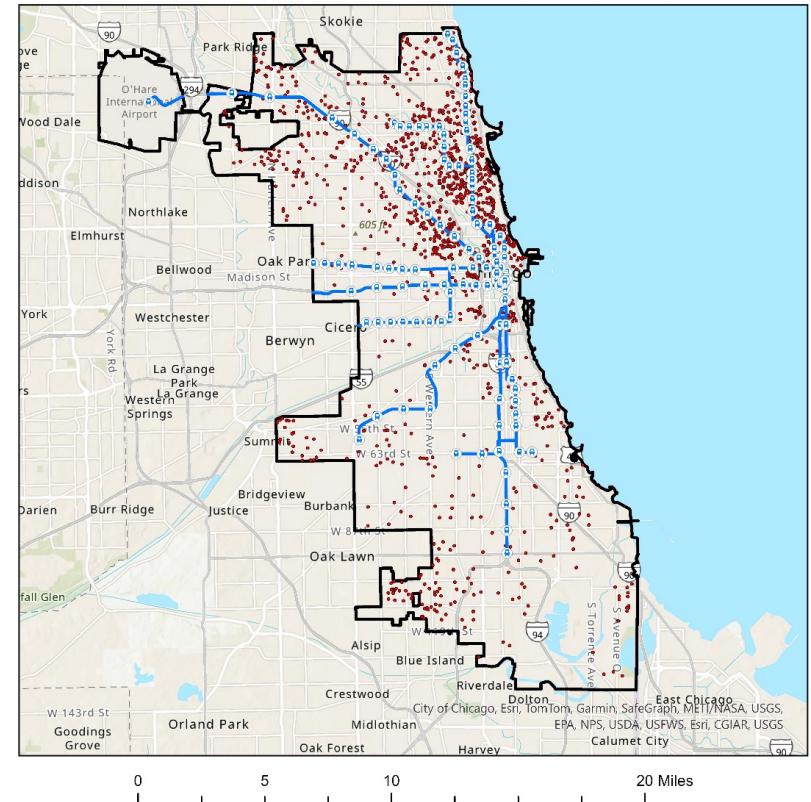
03 METHOD DISCRIPTION



Study Area

Before COVID 19(2016-2019) : 1,381

After COVID 19(2020-2023) : 1,381

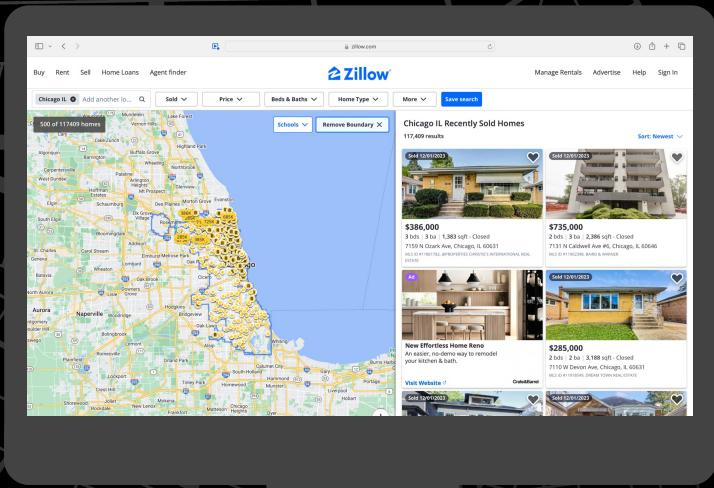


Legend

- CTA_RailStations
- CTA_RailLines
- Transaction Data
- Chicago Boundary



DATA COLLECTION METHOD



Data from 1,381 houses traded in Chicago over the past three years (November 2021 - November 2023) that had at least one transaction between 2016 and 2019 were collected via Zillow.

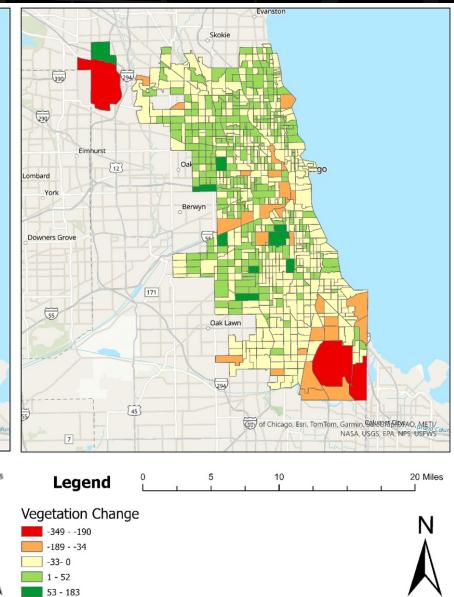
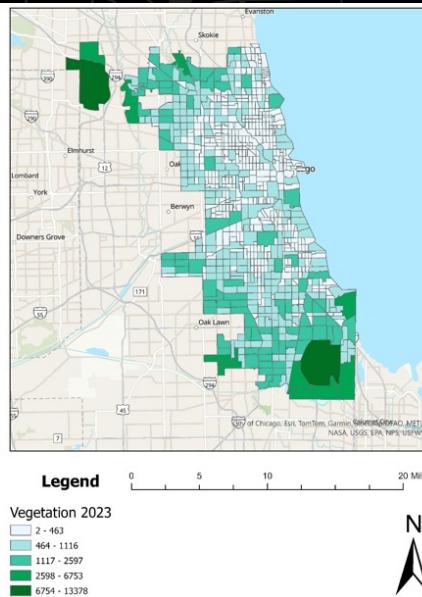
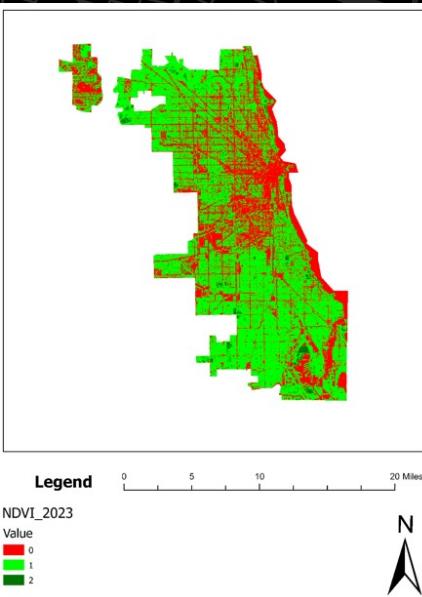
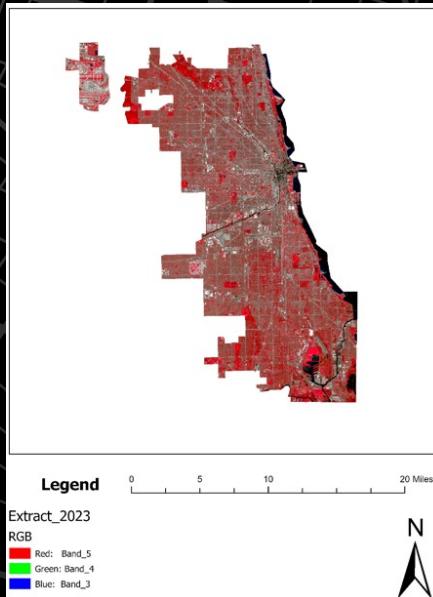
Vegetation Calculation Process

Landsat Data

Calculate NDVI

Calculate Vegetation
by Census Tract

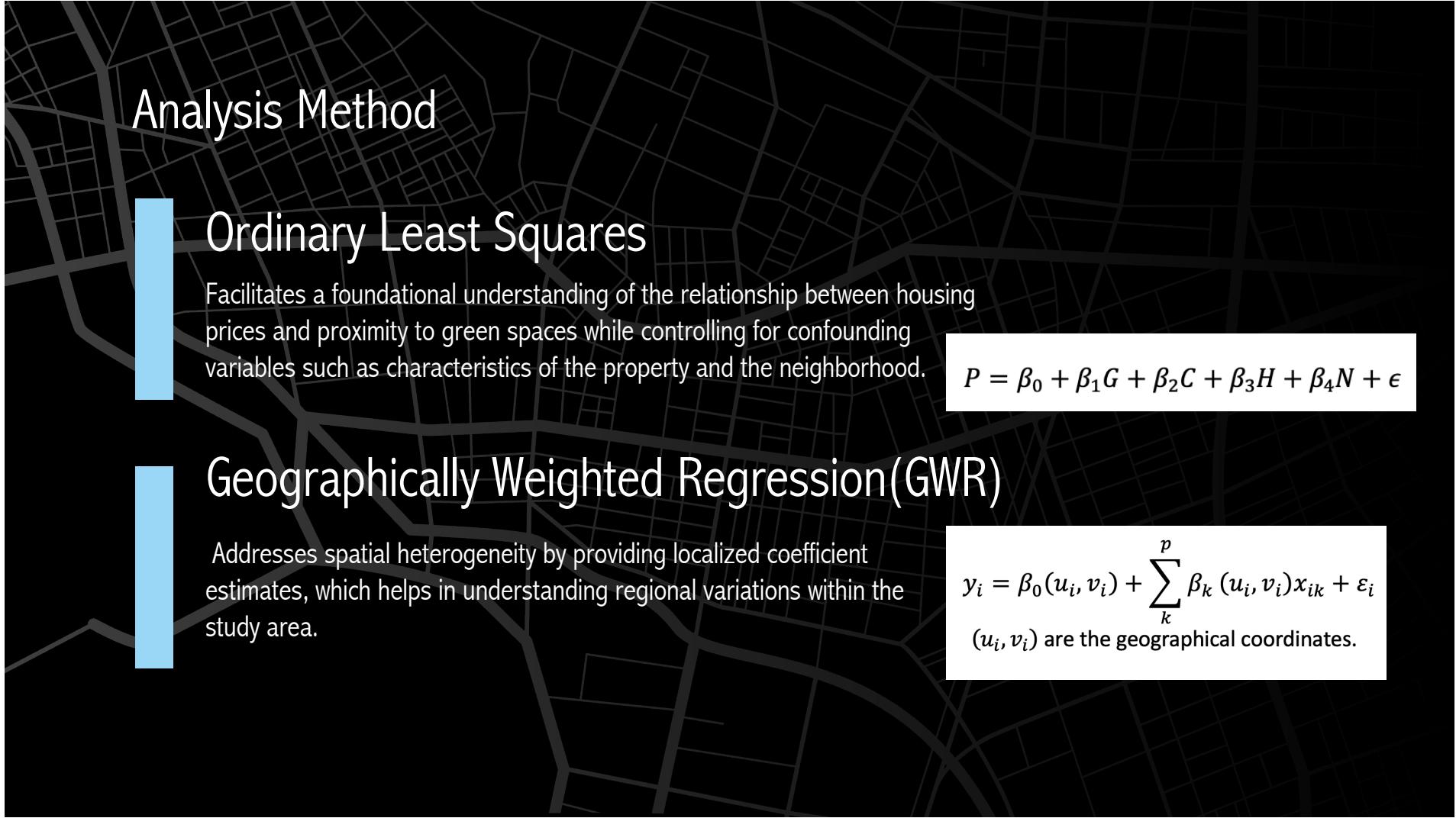
2023 – 2019
Vegetation Change



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B	C	D	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
Possible Data Loss Some features might be lost if you save this workbook in the comma-delimited (.csv) format. To preserve these features, save it in an Excel file format.																								Save As...	
40000	40500	1500	4	20	2023	RECENTLY_S	Closed	1	1	350	45500	CONDO	1965	41.74763	-87.67554	8018 S Hoyne	60620	Chicago	IL	Apt 4	Gresham	Window/W	TRUE		
40000	74400	2108	5	19	2021	SOLD	Sold	0	1	500		APARTMENT		41.8902	-87.61817	480 N McCl	60611	Chicago	IL		Streeterville	On Site Lau	TRUE		
40000	86200	525	4	9	2021	SOLD	Sold	1	1	515	365468	CONDO	1973	41.84082	-87.6262	2941 S Michi	60616	Chicago	IL	Apt 408	South Comm	Refrigerator	TRUE		
54100		1136	3	11	2022	FOR_SALE	Closed	2	1	440	3049	SINGLE_FAM	1915	41.76951	-87.66846	6825 S Woo	60636	Chicago	IL		West Engle	'Range', 'Refrigerator'	TRUE		
64200	63700	1250	2	5	2021	SOLD	Closed	1	1	500		CONDO	1966	41.88921	-87.76134	5424 W Ferd	60644	Chicago	IL	Apt 316	South Austin	'Range', 'Refrigerator'	TRUE		
53000	53800	1749	4	10	2023	RECENTLY_S	Closed	3	1	760	3125	SINGLE_FAM	1925	41.77788	-87.68261	6342 S Clare	60636	Chicago	IL		West Englewood	'Other'	TRUE		
85000	143200	1900	1	11	2023	RECENTLY_S	Closed	3	2	731	2520	MULTI_FAM	1964	41.682907	-87.64464	11611 S Peoi	60643	Chicago	IL		West Pullman	'Central Air'	TRUE		
95000	143200	1900	1	11	2023	RECENTLY_S	Closed	3	2	731	2520	MULTI_FAM	1964	41.682907	-87.64464	11611 S Peoi	60643	Chicago	IL		Englewood	'Central Air'	TRUE		
104900	103500	1665	12	7	2021	SOLD	Closed	3	1	800	3123	SINGLE_FAM	1884	41.789715	-87.64104	5733 S Lowe	60621	Chicago	IL		West Englewood	'Central Air'	TRUE		
115050	197700	1999	5	23	2022	SOLD	Closed	4	2	736	3125	SINGLE_FAM	1978	41.791435	-87.67024	5623 S Hon	60636	Chicago	IL						
125000	155300	1200	3	17	2022	FOR_SALE	Closed	1	1	600		CONDO	1929	41.9332	-87.76898	5704 W Geo	60634	Chicago	IL	# 1	Belmont Cen	'Range', 'Refrigerator', 'S'	TRUE		
135000	52400	1749	3	14	2022	SOLD	Closed	3	1	748	3001	SINGLE_FAMILY	1916	41.80721	-87.65229	2048 W 48th	60609	Chicago	IL		Back of the Yards	'Window/W	TRUE		
145000	66100	1300	2	28	2022	SOLD	Sold	2	1	750	18550	APARTMENT	1964	41.765785	-87.610146	106 E 71st St	60619	Chicago	IL		Park Manor	On Site Lau	TRUE		
155000	122100	1800	9	16	2021	SOLD	Closed	4	2	800	1504	TOWNSHOUS	1947	41.727295	-87.28456	9157 S Went	60620	Chicago	IL		Princeton Park	'Central Air'	TRUE		
165000	81100	1300	6	17	2021	SOLD	Closed	2	1	800		CONDO	1930	41.874725	-87.71119	3408 W Cong	60624	Chicago	IL	# 1	Fifth City	'Range', 'Microwave', 'Re'	TRUE		
175000		1355	11	3	2021	SOLD	Closed	2	1	805	3123	SINGLE_FAM	1900	41.694977	-87.629745	245 W 109th	60628	Chicago	IL		Roseland	'Central Air'	TRUE		
1846500	81600	1099	10	29	2021	SOLD	Closed	2	1	546	3125	SINGLE_FAM	1920	41.750572	-87.55686	7942 S Burnl	60617	Chicago	IL		South Chicago	'Curbs', Sid	TRUE		
1952500	79600	2250	7	15	2021	SOLD	Closed	1	1	714		CONDO	1925	41.794596	-87.58135	1765 E 55th	60615	Chicago	IL	Apt E6	Hyde Park	'Window/W	TRUE		
2053000	99500	1300	12	28	2020	SOLD	Closed	2	1	816	3615	SINGLE_FAM	1949	41.712121	-87.614494	9518 S King I	60628	Chicago	IL		Rosemoor	'Central Air'	TRUE		
2149000	167800	1999	12	11	2020	SOLD	Closed	4	2	750	4617	SINGLE_FAM	1954	41.669076	-87.6386	12813 S Unic	60628	Chicago	IL		West Pullman	'Central Air'	TRUE		
2254000	98600	1300	11	25	2020	SOLD	Sold	2	1	850	26012	CONDO	1929	41.801445	-87.67757	2112 W 51st	60609	Chicago	IL	# A-3	Back of the Y []	Central]	TRUE		
2358000	59800	1300	1	31	2023	RECENTLY_S	Closed	2	1	800		CONDO	1940	41.74567	-87.57622	8210 S Jeffei	60617	Chicago	IL		Unit 9	South Chicag	'Range', 'Microwave', 'Re'	TRUE	
2455000	62900	1200	2	25	2022	SOLD	Closed	1	1	500		CONDO	1966	41.88921	-87.76134	5424 W Ferd	60644	Chicago	IL	Apt 104	South Austin	'Window/W	TRUE		
2559000	61400	1800	10	13	2022	SOLD	Closed	3	2	670	2496	SINGLE_FAM	1970	41.744198	-87.60057	948 E 83rd S	60619	Chicago	IL		East Chatham	'Central Air'	TRUE		
2656000	68600	1074	10	26	2021	SOLD	Closed	1	1	594	3136	SINGLE_FAM	1920	41.706425	-87.64186	10314 S Emme	60628	Chicago	IL		Fernwood	'Central Air'	TRUE		
2754900	70500	1250	9	15	2021	SOLD	Closed	1	1	800		CONDO	1962	41.762733	-87.55865	7363 S South	60649	Chicago	IL	Apt 407	South Shore	'Window/W	TRUE		
2858000	58900	1260	8	30	2021	SOLD	Sold	2	1	850	17050	APARTMENT	1927	41.7461	-87.60295	8158 S Drex	60619	Chicago	IL		East Chathar	'Dryer', 'Wa []	TRUE		
2957000	73100	1714	3	23	2022	SOLD	Sold	0	1	450	10415	CONDO	1969	41.906937	-87.6350	1340 N Dear	60610	Chicago	IL	# G18	Gold Coast	'Dishwashe' On Site Lau	TRUE		
3055000	101100	1999	7	22	2021	SOLD	Closed	3	2	731	2728	TOWNHOUSE	1966	41.68214	-87.646515	951 W 116th	60643	Chicago	IL		West Pullman	'Central Air'	TRUE		
3155000	101100	1999	7	22	2021	SOLD	Closed	3	2	731	2728	TOWNHOUSE	1966	41.68214	-87.646515	951 W 116th	60643	Chicago	IL		West Pullman	'Central Air'	TRUE		
3258800	93800	1300	5	30	2023	RECENTLY_S	Closed	1	1	80		CONDO	1971	41.808186	-87.719475	3816 W 47th	60632	Chicago	IL	# 3RDFR	Archer Heights	'Window/W	TRUE		
3354000	87900	1300	1	4	2021	SOLD	Closed	0	1	700		CONDO	1948	41.79858	-87.74558	5470 S Arche	60638	Chicago	IL	Apt 3B	Vittum Park	'Window/W	TRUE		
3457500	96200	997	12	4	2020	SOLD	Sold	0	1	400	24705	CONDOS	1979	41.97248	-87.84512	5117 N East	60656	Chicago	IL	Unit 1E	O'Hare	'Range / Ov []	TRUE		
3555000	96600	1200	12	3	2020	SOLD	Sold	1	1	800	8586	CONDO	1963	41.794422	-87.766624	5418 S Mass	60638	Chicago	IL	Unit 2	Garfield Ridg	'Range / Ov []	TRUE		
3660000	60000	1250	10	16	2023	RECENTLY_S	Closed	1	1	750		CONDO	1962	41.762947	-87.55887	7355 S South	60649	Chicago	IL	Apt 403	South Shore	'Range', 'Refrigerator'	TRUE		
3760000	59700	1175	8	25	2023	RECENTLY_S	Closed	1	1	650	4500	SINGLE_FAM	1922	41.74591	-87.61594	8153 Calun	60619	Chicago	IL		Chatham	'Central Air'	TRUE		
3864000	63800	1350	9	27	2023	RECENTLY_S	Closed	2	1	1038	3750	SINGLE_FAM	1923	41.743607	-87.58154	1732 E 83rd	60617	Chicago	IL		Stony Island Park	'Window/W	TRUE		
3961000	287600	1975	7	28	2023	FOR_SALE	Sold	4	2	1000	4340	SINGLE_FAM	1915	41.757492	-87.61421	7530 S Vern	60619	Chicago	IL		Chatham	'Range', 'Microwave', 'Re'	TRUE		
4060000	1700	1700	7	27	2023	RECENTLY_S	Closed	3	1	804	3300	SINGLE_FAM	1927	41.69566	-87.63374	10847 S Egg	60628	Chicago	IL		Roseland	'Central Air'	TRUE		
4160000	59800	1150	7	26	2023	RECENTLY_S	Closed	1	1	900		CONDO	1922	41.7731	-87.58289	6710 S Ridge	60649	Chicago	IL	# 1B	South Shore	'Central Air'	TRUE		
4262000	113900	1099	5	24	2023	RECENTLY_S	Sold	1	1	500	6098	SINGLE_FAM	1910	41.652546	-87.5359	13337 S Avei	60633	Chicago	IL		Hegewisch	[]	TRUE		
4360000	61000	1087	3	29	2023	RECENTLY_S	Closed	1	1	950		CONDO	1924	41.755398	-87.550674	3017 E 78th	60649	Chicago	IL	Apt 3A	South Shore	'Window/W	TRUE		

Composition of Variables

Variable category	Variable name	Value type	Definition
Dependent variable	Transaction price (per square feet)	\$(Dollar)	Actual transaction price divided by exclusive use area
	Vegetation Change	Ratio scale	Vegetation change between 2019 and 2023
	Period	Before Covid-19 & After Covid-19 Dummy	(0, 1) Before (0) & After(1) dummy(ref.before covid-19)
	Housing characteristics	Area for exclusive use Number of beds Number of baths Year Cooling availability Heating availability Parking availability Ridership	Ratio scale Ratio scale Ratio scale Ratio scale (0, 1) (0, 1) (0, 1) Ratio scale Divided into no cooling (0) and cooling system available (1) (ref.no cooling) Divided into no heating (0) and heating system available (1) (ref.no heating) Divided into no parking (0) and parking available (1) (ref.no parking) Total number of monthly passengers at the nearest station (based on the month transacted)
Independent variable	Distance to station Primary school rating High school rating Distance to general hospital	Ratio scale Ratio scale Ratio scale Ratio scale	Distance to the nearest Elevated Train station (mile) Based on research conducted by GreatSchools.org, an independent non-profit organization, It is based on four levels of the School Assessment Scale: Student Progress Rating or Academic Progress Rating, College Readiness Rating, Equity Rating, and Test Score Rating. Distance to the nearest general hospital (mile)



Analysis Method

Ordinary Least Squares

Facilitates a foundational understanding of the relationship between housing prices and proximity to green spaces while controlling for confounding variables such as characteristics of the property and the neighborhood.

$$P = \beta_0 + \beta_1 G + \beta_2 C + \beta_3 H + \beta_4 N + \epsilon$$

Geographically Weighted Regression(GWR)

Addresses spatial heterogeneity by providing localized coefficient estimates, which helps in understanding regional variations within the study area.

$$y_i = \beta_0(u_i, v_i) + \sum_k^p \beta_k(u_i, v_i)x_{ik} + \varepsilon_i$$

(u_i, v_i) are the geographical coordinates.



Analysis Method

Multiscale Geographically Weighted Regression (MGWR)

Builds on GWR by allowing different variables to operate at their optimal spatial scales, enhancing the model's sensitivity to local context.



04

ANALYSIS RESULT



Analysis Result : OLS Analysis

Ordinary Least Squares(OLS)			
	B	Std Error	VIF
Vegetation Changes	0.001*	0.000	1.067
Covid Dummy	-0.090***	0.020	1.358
Housing Characteristics			
Area	0.000	0.000	3.631
Number of beds	-0.016***	0.011	2.414
Number of baths	0.091***	0.016	3.479
Age	-0.002***	0.000	1.281
Cooling availability (ref.no cooling)	0.275***	0.032	1.518
Heating availability (ref.no heating)	-0.112**	0.036	1.552
Parking availability (ref.no parking)	0.069**	0.020	1.325
Ridership	0.000**	0.000	1.421
Distance to station	-0.148***	0.009	1.406
Surrounding environment characteristics			
Primary school rating	0.039***	0.004	1.228
High school rating	0.022***	0.004	1.262
Distance to general hospital	-0.022*	0.009	1.191
Constant	5.566***		
N	2,414		
AICc	2653.668***		
R2	0.359		
Adjusted R2	0.355		

Dependent variable: Transaction price per square feet (\$ Dollar) - *p<0.05, **p<0.01, ***p<0.001

Analysis Result : Spatial Autocorrelation

Global Moran's I Summary

Moran's Index	0.645556
Expected Index	-0.000414
Variance	0.0007
z-score	24.424081
p-value	0.000000

Comparison of MGWR and GWR Model Indicators

Model Index	MGWR	GWR
Adjusted R^2	0.688	0.825
AICc	4743.196	31347.13
Sum of squares of residuals	476.731	2588354.84

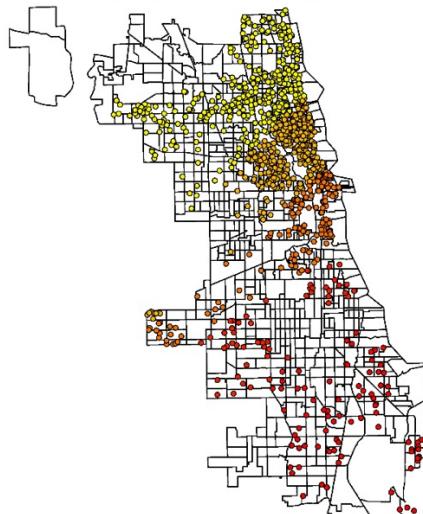
Analysis Result : Comparison of OLS and MGWR

		Ordinary Least Squares(OLS)			Multiscale Geographically Weighted Regression(MGWR)				
		B	Std Error	VIF	Mean	Standard Deviation	Min	Median	Max
Vegetation Changes		0.001*	0.000	1.067	-0.033	0.005	-0.037	-0.034	-0.015
Covid Dummy		-0.090***	0.020	1.358	-0.110	0.058	-0.269	-0.098	-0.017
	Area	0.000	0.000	3.631	-0.276	0.190	-0.924	-0.221	0.001
	Number of beds	-0.016***	0.011	2.414	0.155	0.035	0.088	0.151	0.213
	Number of baths	0.091***	0.016	3.479	0.099	0.026	0.077	0.091	0.173
	Age	-0.002***	0.000	1.281	-0.050	0.083	-0.319	-0.036	0.190
	Cooling availability (ref.no cooling)	0.275***	0.032	1.518	0.075	0.068	-0.067	0.059	0.310
	Heating availability (ref.no heating)	-0.112**	0.036	1.552	-0.044	0.004	-0.047	-0.046	-0.031
Housing Characteristics	Parking availability (ref.no parking)	0.069**	0.020	1.325	0.016	0.031	-0.020	0.006	0.089
	Ridership	0.000**	0.000	1.421	0.009	0.003	-0.001	0.010	0.011
	Distance to station	-0.148***	0.009	1.406	-0.170	0.002	-0.172	-0.171	-0.165
Surrounding environment characteristics	Primary school rating	0.039***	0.004	1.228	0.080	0.003	0.070	0.081	0.082
	High school rating	0.022***	0.004	1.262	0.131	0.002	0.125	0.131	0.132
	Distance to general hospital	-0.022*	0.009	1.191	-0.006	0.268	-1.131	-0.009	1.582
Constant		5.566***			0.022	0.640	-2.002	0.206	0.979
N		2,414				2,414			
AICc		2653.668***				4743.196***			
R2		0.359				0.752			
Adjusted R2		0.355				0.688			

Dependent variable: Transaction price per square feet (\$ Dollar) - *p<0.05, **p<0.01, ***p<0.001

MGWR Result

Coefficient_Vegetation Change

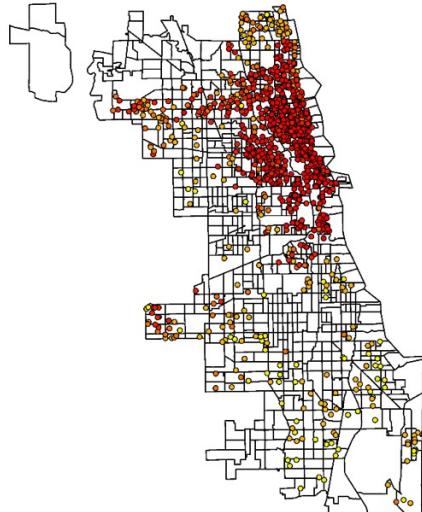


Legend

- -0.000908 - -0.000848
- -0.000847 - -0.000793
- -0.000792 - -0.000690
- -0.000689 - -0.000535
- -0.000534 - -0.000367
- Census Tract



Predicted_Log Price



Legend

- 4.070252 - 4.985432
- 4.985433 - 5.374626
- 5.374627 - 5.731769
- 5.731770 - 5.973199
- 5.973200 - 6.960625
- Census Tract



Housing prices decline as vegetation increases:
impact is greater in southern areas

Housing prices are higher in the north.

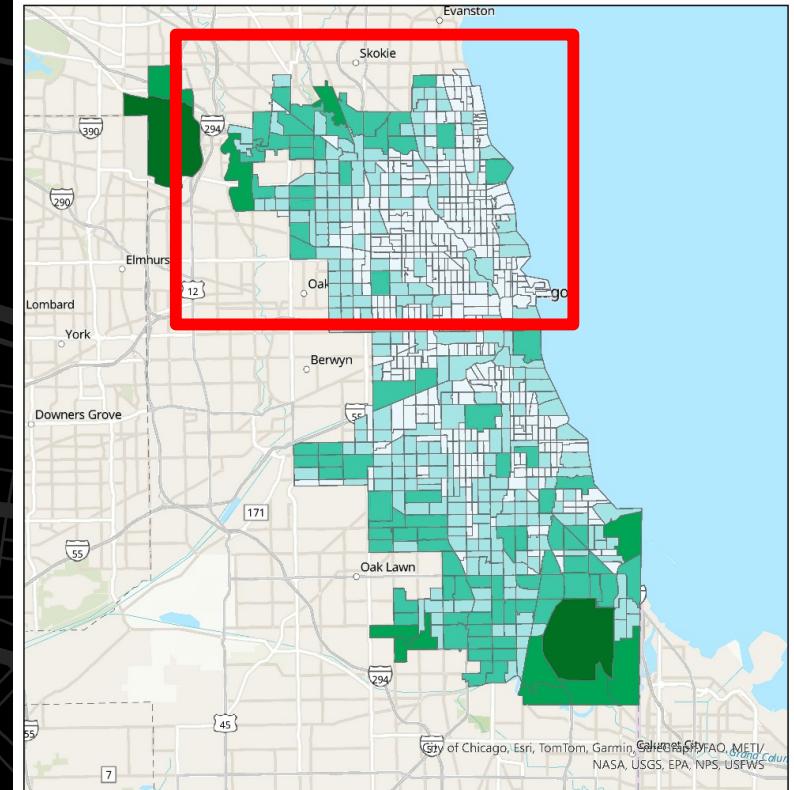


05 Conclusion

Findings

1. Increased vegetation generally reduces housing prices, but effects are uneven across different areas

Particularly significant impact on Chicago's North Side



Legend

Light Blue	2 - 463
Medium Blue	464 - 1116
Cyan	1117 - 2597
Dark Green	2598 - 6753
Very Dark Green	6754 - 13378

0 5 10 20 Miles



Findings

2. Influence of Socio-Economic Factors on Vegetation Impact

The influence of increased vegetation on housing prices is moderated by socio-economic factors. While the southern parts of Chicago, which generally feature low-income neighborhoods, show less sensitivity to increases in greenery in terms of housing price changes, the northern parts of the city, which are predominantly high-income areas, demonstrate a more pronounced decline in property values with increased vegetation.

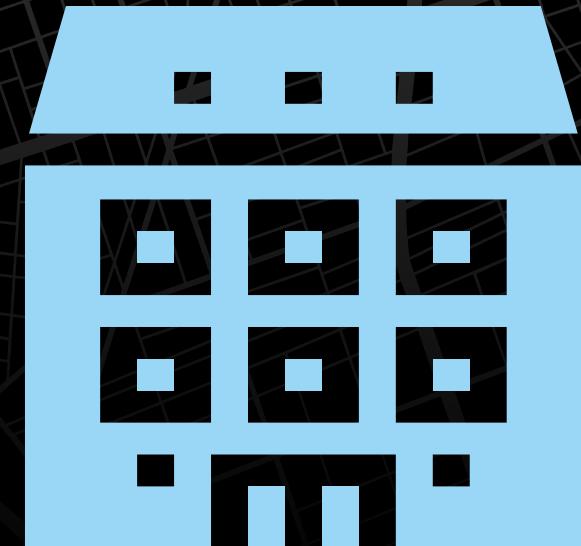
Policy Implication & Limitation

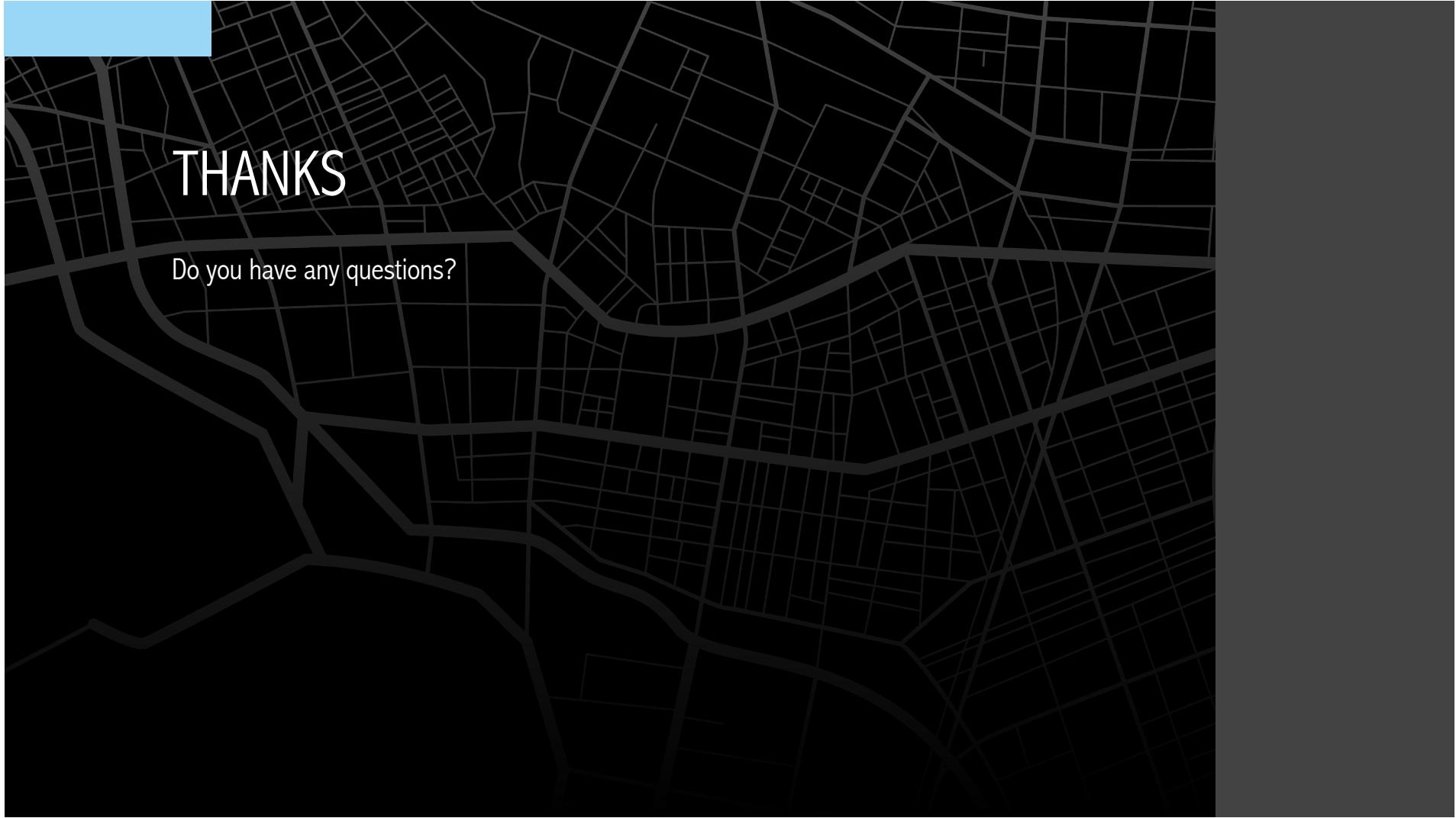
Limitations

Potential biases in data sources

Policy Implications

Importance of tailored urban planning that considers local conditions and green space integration.





A map of a city street network is shown against a black background. A horizontal blue bar is positioned at the top left. The map features a dense grid of streets with varying line weights, suggesting major and minor roads. A prominent curved line, possibly a river or a major highway, cuts through the grid.

THANKS

Do you have any questions?