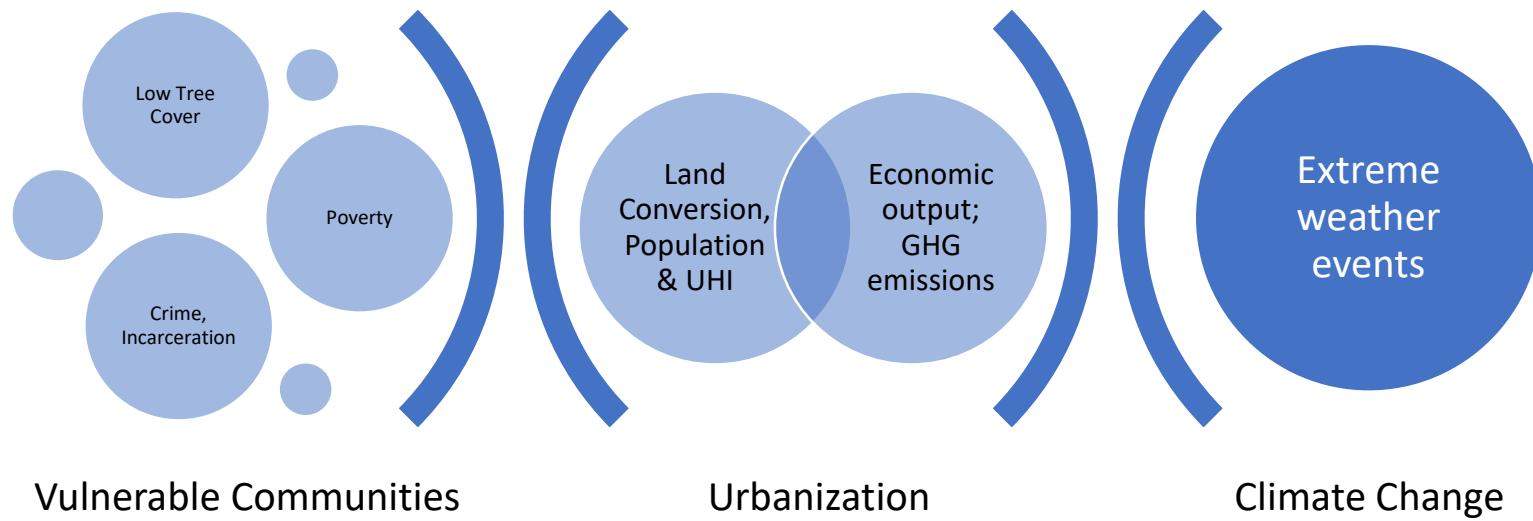


Equity Issues in Urban Forestry & Green Infrastructure

Colleen Murphy-Dunning
March 24, 2020

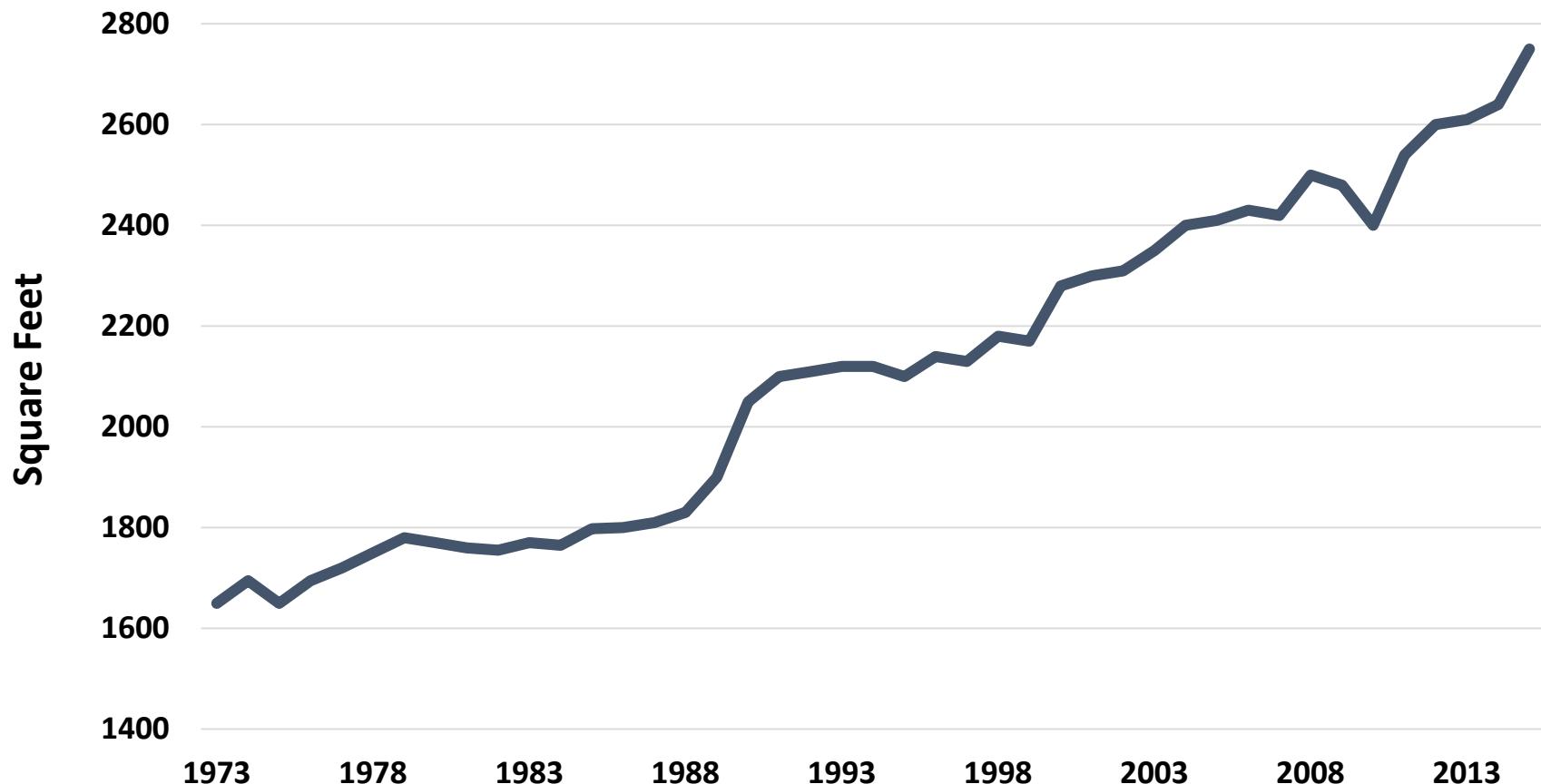


20,000 American football fields becoming urban every day for 30 years

- Increase in urban land by 2030: ~2.3m km²

	Urban Land in 2000 (km ²)	Urban Land in 2030 (km ²)			Avg Increase (%)
		min	avg	max	
AFRICA	41,450	178,721	345,263	797,395	733
AMERICA	224,025	370,395	580,348	860,110	159
ASIA	225,825	689,881	1,129,354	1,980,541	400
EUROPE	151,075	215,168	266,193	313,610	76
OCEANIA	10,450	13,034	23,321	42,197	123
TOTAL	652,825	1,467,199	2,344,479	3,993,853	259

Average Home Size, U.S.



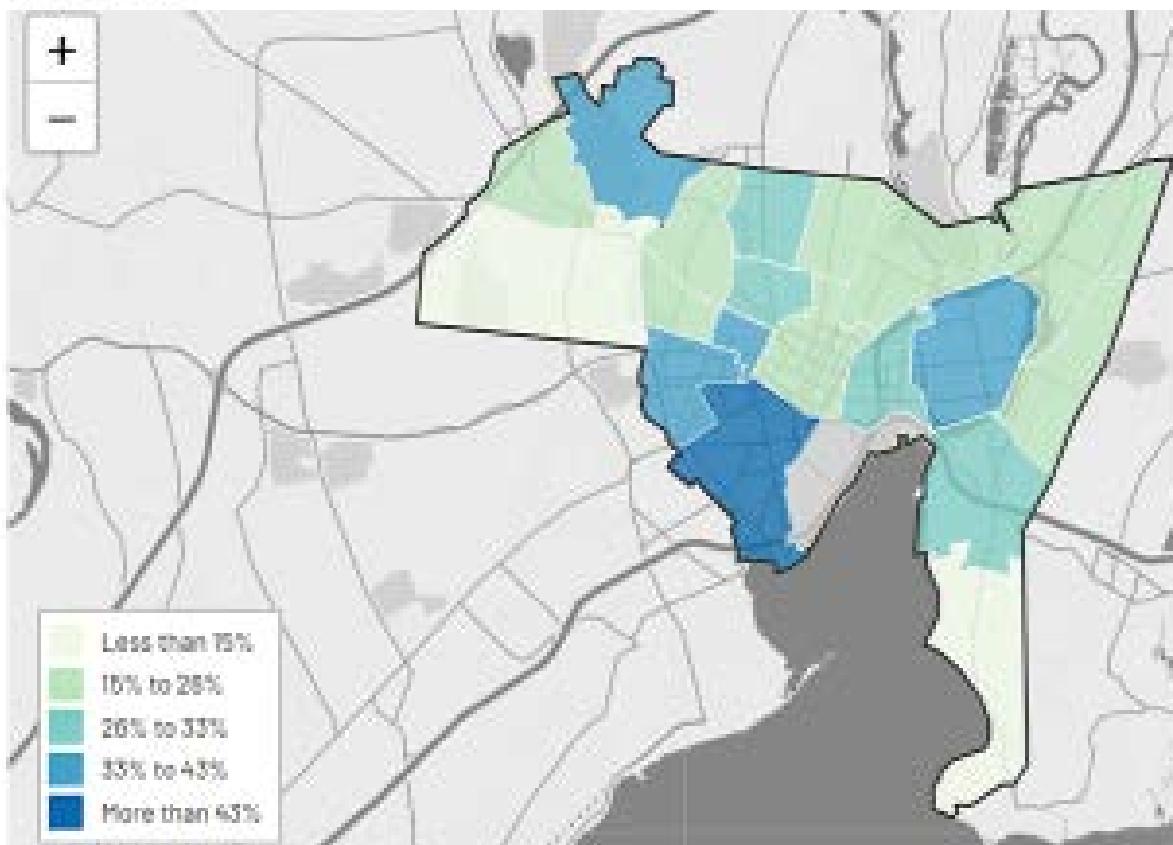


130,000 people
38% canopy cover
30,000 street trees

VULNERABLE POPULATIONS

Economic Inequality in New Haven Neighborhoods

2016



Hill - Income

Poverty status known: 15,684

Population in poverty: 6,741

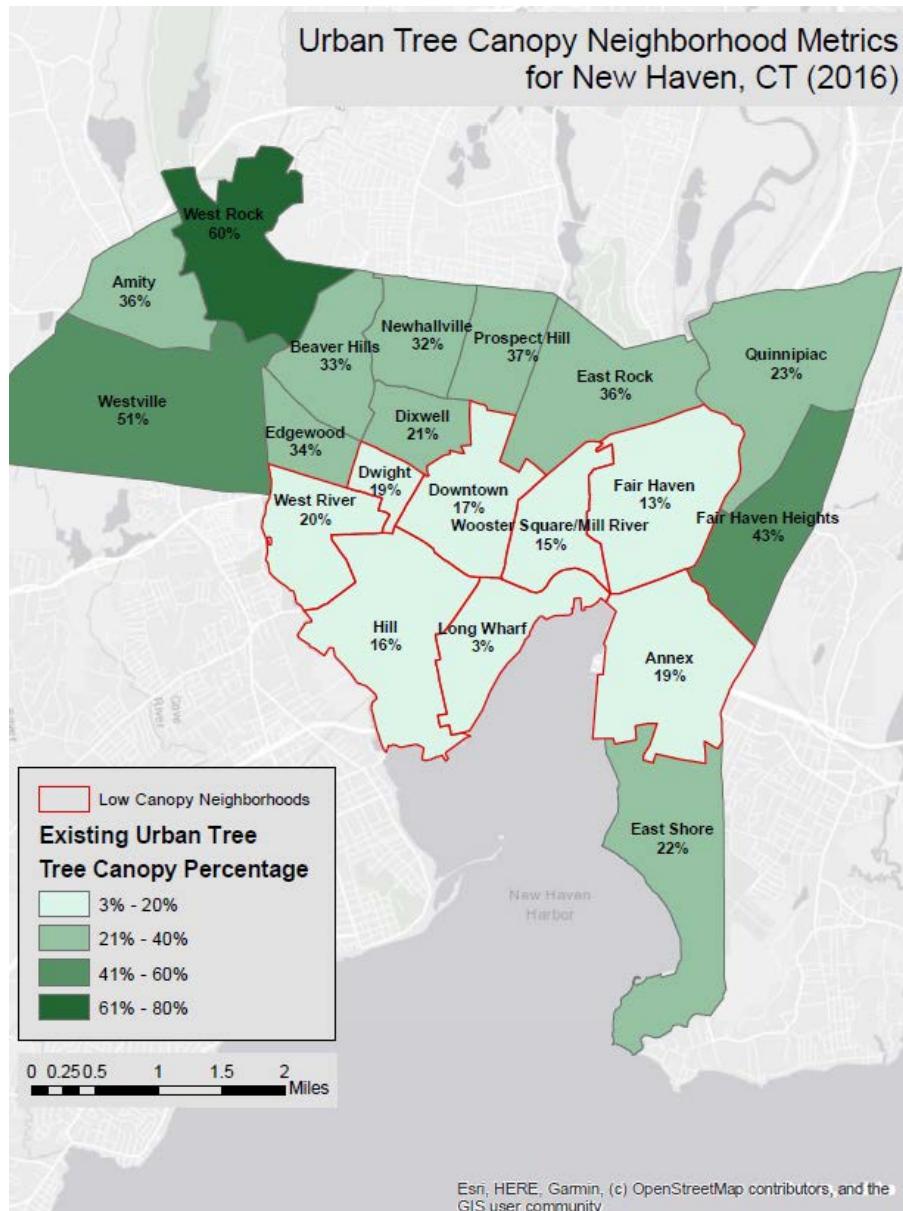
Poverty rate: 43%

Low-income population: 11,020

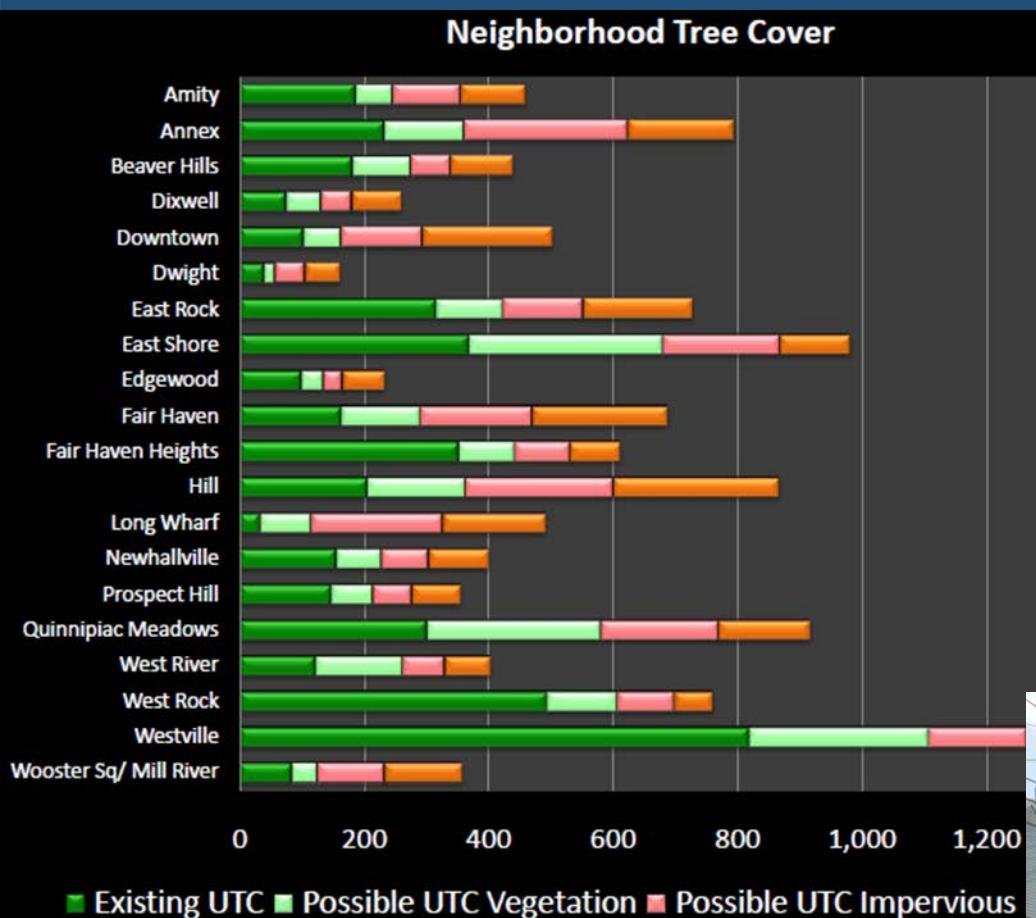
Low-income rate: 70%

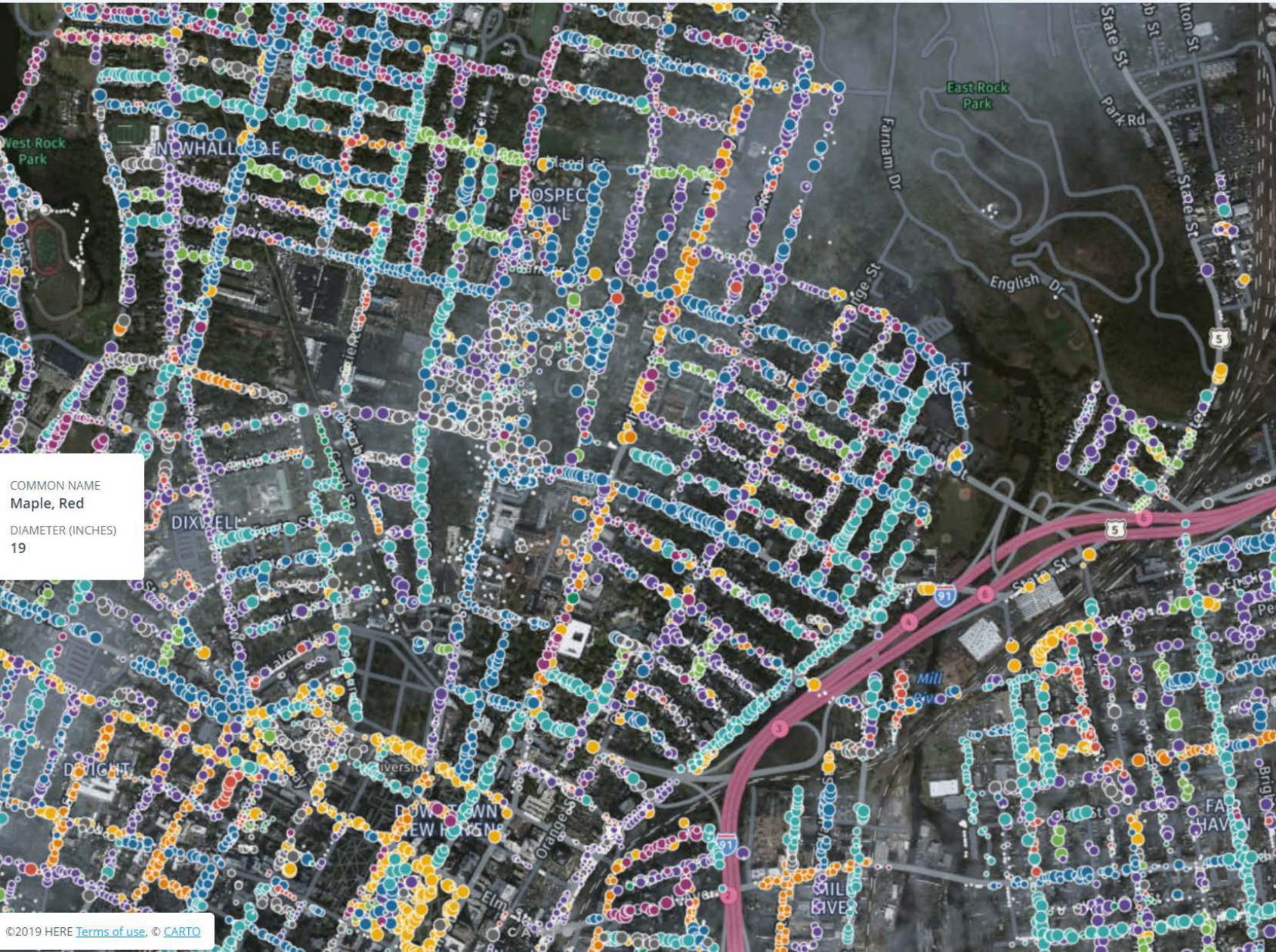
High-income population: 1,172

High-income rate: 9%



Source: Jarlath O'Neill Dunne,
VT Spatial Analysis Lab



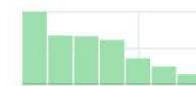


New Haven Street

13,362

Diameter (inches)

12K SELECTED



Common Name

ALL SELECTED

OAK, PIN

MAPLE, NORWAY

PLANETREE, LONDON

OAK, RED

LINDEN, LITTLELEAF

OTHER

SEARCH IN 162 CATEGORIES

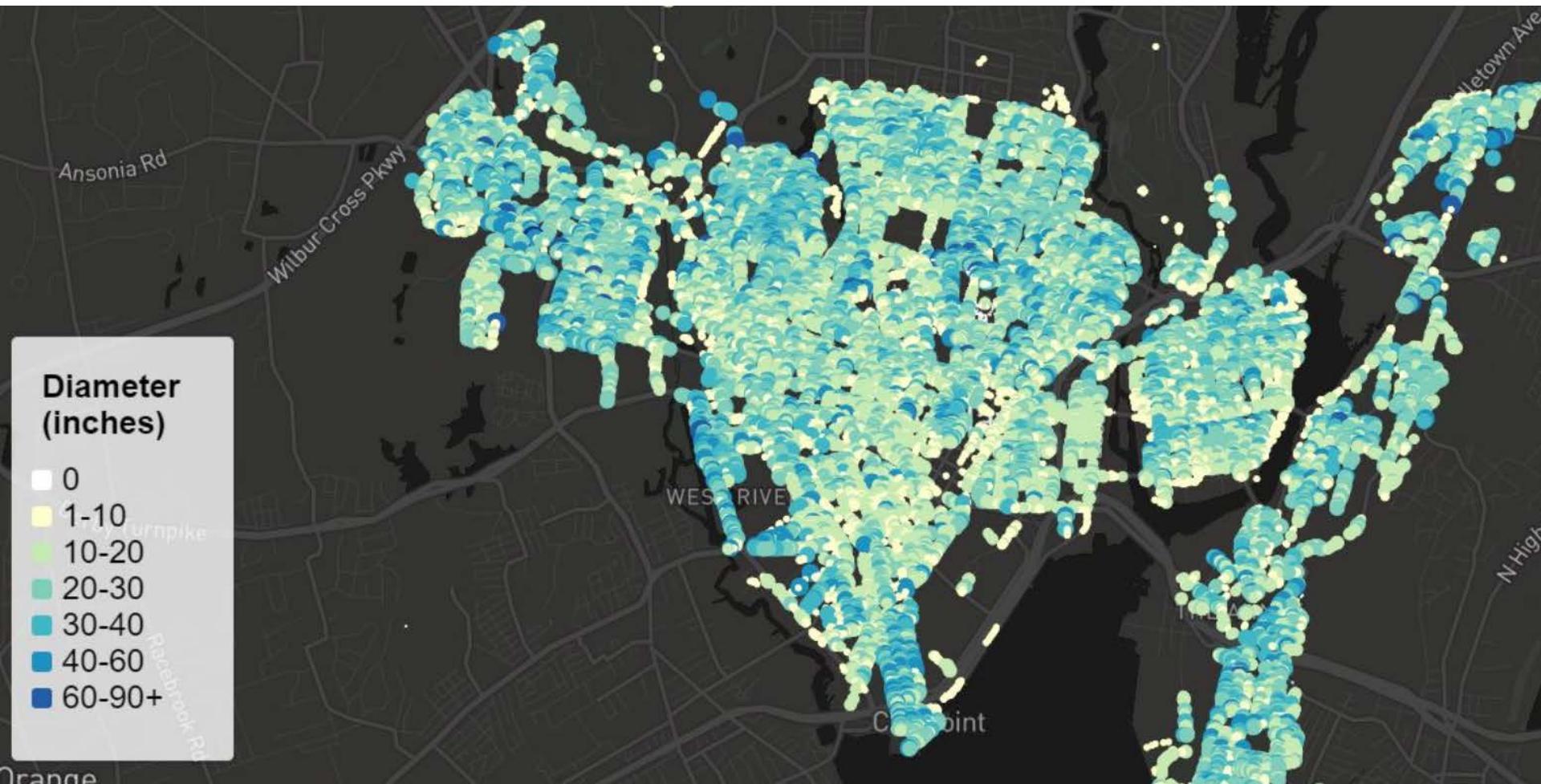
Genus

ALL SELECTED

ACER

QUERCUS

PLATANUS



Zone	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)
Amity	64,577	1,795	12,314	17,525	51,677	147,888
Annex	68,430	2,023	13,168	18,636	59,857	162,115
Beaver Hills	124,455	3,678	23,655	34,348	101,167	287,303
Dixwell	83,998	2,181	14,787	19,242	82,603	202,811
Downtown	38,923	1,016	6,944	9,298	49,997	106,178
Dwight	52,262	1,360	9,256	11,461	52,349	126,688
East Rock	135,315	3,623	24,392	33,124	125,406	321,860
East Shore	118,957	3,216	21,943	30,614	95,461	270,193
Edgewood	56,318	1,577	10,036	13,322	60,949	142,202
Fair Haven	156,784	4,352	28,420	37,545	152,179	379,280
Fair Haven Heights	65,551	1,795	12,008	15,919	60,895	156,168
Hill	156,119	4,294	28,599	39,938	147,435	376,384
Long Wharf	10,551	275	1,906	2,851	9,321	24,904
Newhallville	109,618	2,877	19,459	26,204	105,563	263,720
Prospect Hill	82,057	2,077	14,404	19,047	78,599	196,184
Quinnipiac Meadows	46,919	1,076	8,371	11,151	36,787	104,305
West River	43,118	1,223	7,984	10,859	42,135	105,318
West Rock	18,093	449	3,159	4,164	13,724	39,589
Westville	180,367	5,138	34,174	50,429	155,890	426,000
Wooster Square/Mill	87,408	2,005	15,015	18,869	74,408	197,706
Citywide total	1,699,820	46,031	309,995	424,546	1,556,403	4,036,795

Air Quality

- 59,951 lbs of air pollutants are deposited on the leaf area or are avoided via energy conservation per year.
- **Carbon Sequestration, Avoided, Deposited**
- Annually, CO₂ sequestered 7,516,183 lbs; avoided 8,034,091 lbs
- Street trees store an estimated 168,755,600 lbs of carbon

Stormwater

Leaves intercepts a total of 53,064,590 gallons of rainfall (estimated annual value of \$424,546)

Energy Conservation

saves 2,667.4 Megawatt hours of electricity
saves 941,847 therms of natural gas.

Greg McPherson
“STRATUM”;
David Nowak
“I-Tree”



Modeled PM_{2.5} removal by trees in ten U.S. cities and associated health effects

David I. Nowak^{a,*}, Satoshi Hirabayashi^b, Allison Rodine^b, Robert Hoehn^a

Table 5

Estimated removal of PM_{2.5} by trees and associated value in several U.S. cities.

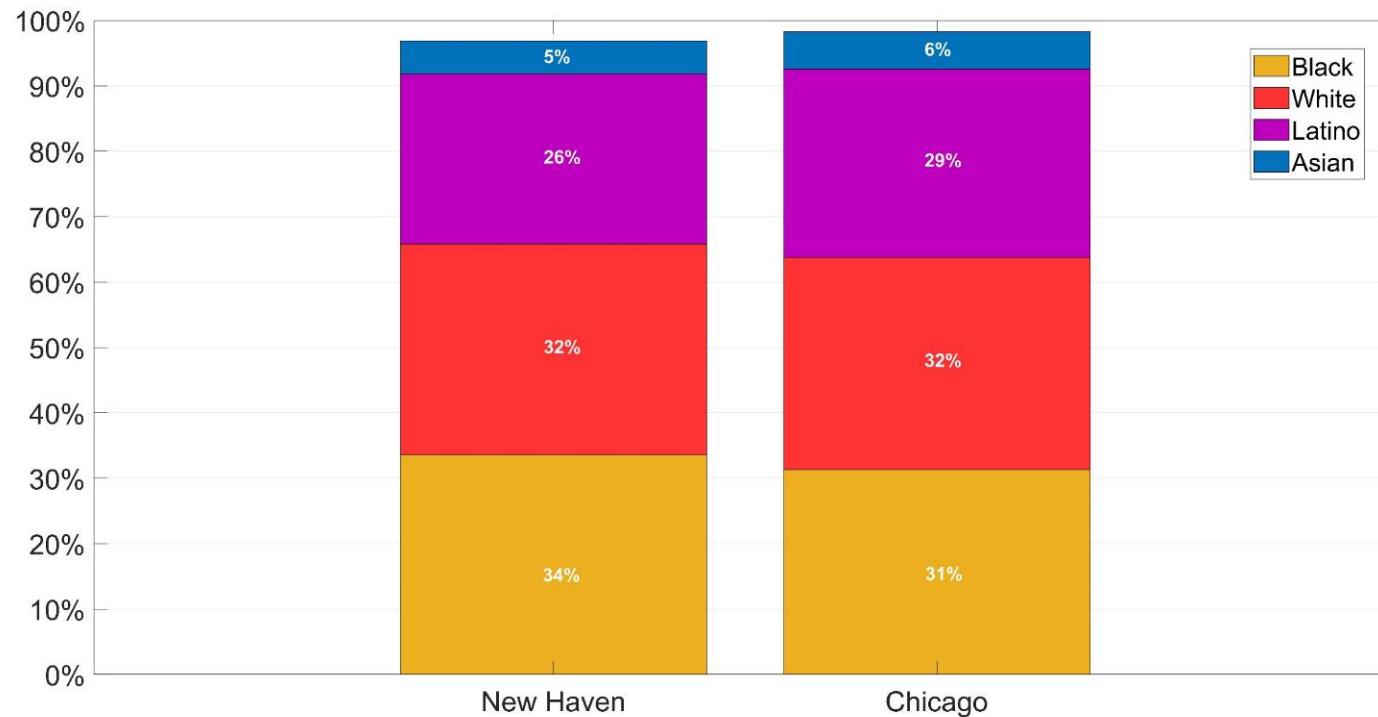
City	Total (t yr ⁻¹)	Range (t yr ⁻¹)	Value (\$ yr ⁻¹)	Effect ^a : m ⁻² yr ⁻¹		ΔC ^b (μg m ⁻³)
				(g)	(\$)	
Atlanta, GA	64.5	(8.5–140.4)	9 170 000	0.36	0.05	0.030
Baltimore, MD	14.0	(1.8–29.5)	7 780 000	0.24	0.13	0.010
Boston, MA	12.7	(2.0–35.6)	9 360 000	0.32	0.23	0.020
Chicago, IL	27.7	(4.0–68.1)	25 860 000	0.26	0.24	0.011
Los Angeles, CA	32.2	(4.2–70.3)	23 650 000	0.13	0.09	0.009
Minneapolis, MN	12.0	(1.6–28.2)	2 610 000	0.23	0.05	0.010
New York, NY	37.4	(5.1–97.2)	60 130 000	0.24	0.38	0.010
Philadelphia, PA	12.3	(1.6–28.1)	9 880 000	0.17	0.14	0.006
San Francisco, CA	5.5	(0.8–14.4)	4 720 000	0.29	0.25	0.006
Syracuse, NY	4.7	(0.6–10.8)	1 100 000	0.27	0.06	0.009

^a Average effects per square meter of tree cover per year: removal in grams and dollar value.

^b Average annual reduction in hourly concentration.

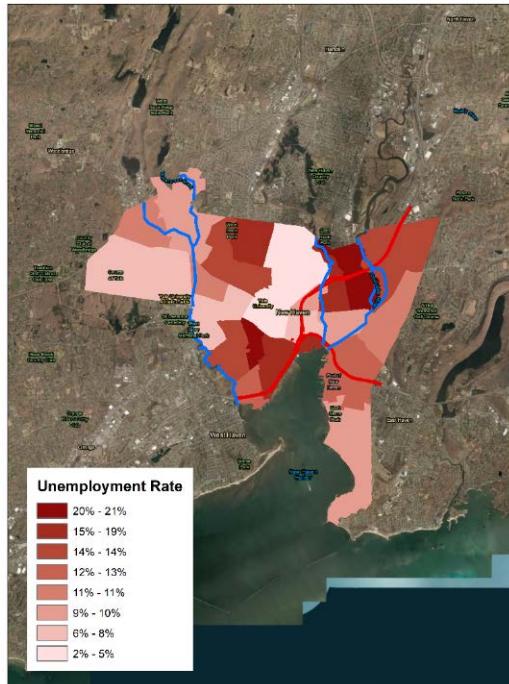
^c Average percent air quality improvement.

Ratio & Ethnicity in New Haven and Chicago

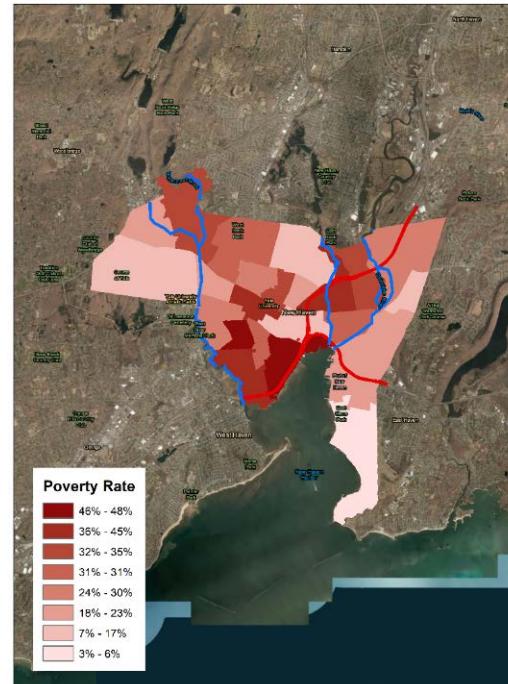


Source: American Community Survey
5-year estimation: 2010 - 2014

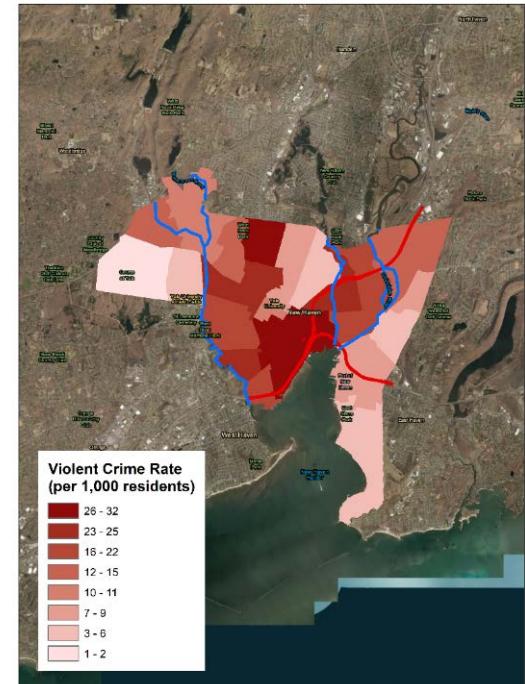
Vulnerability Indices in New Haven



Source: American Community Survey 5-year estimation: 2010 - 2014

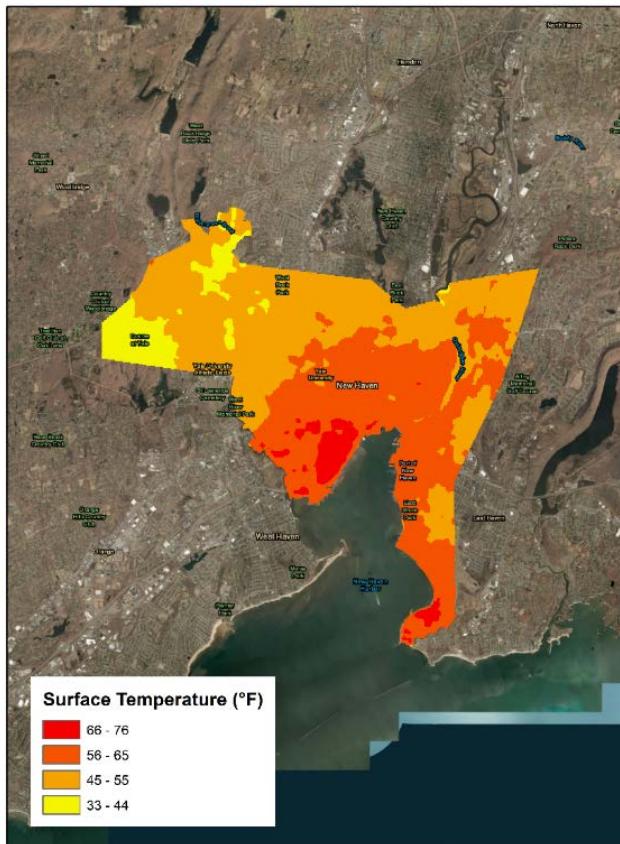


Source: American Community Survey 5-year estimation: 2010 - 2014

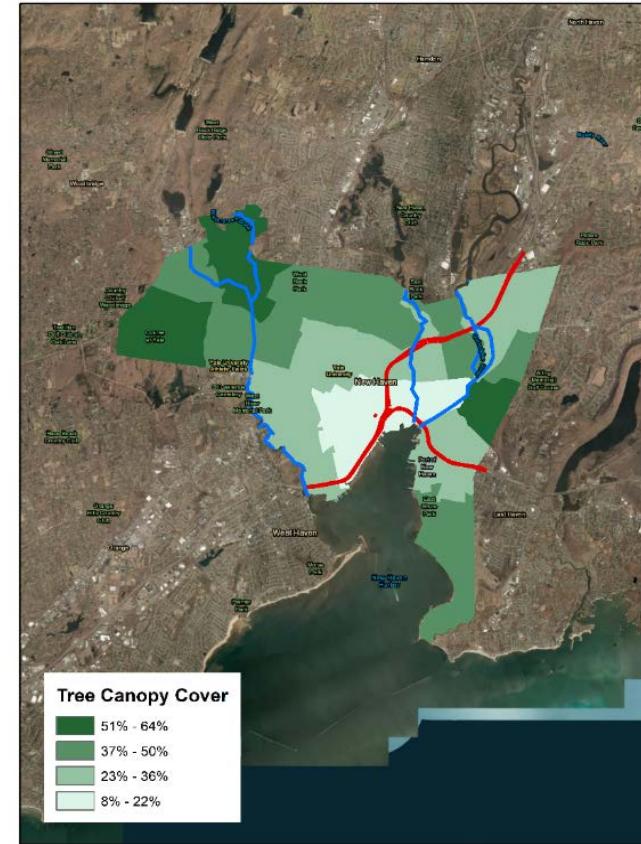


Source: FBI Uniform Crime Reports in "Geospatial Analysis of Violent Crime & Premature Coronary Heart Disease" by Sarah Elise Conderino

Surface Temperature & Tree Cover

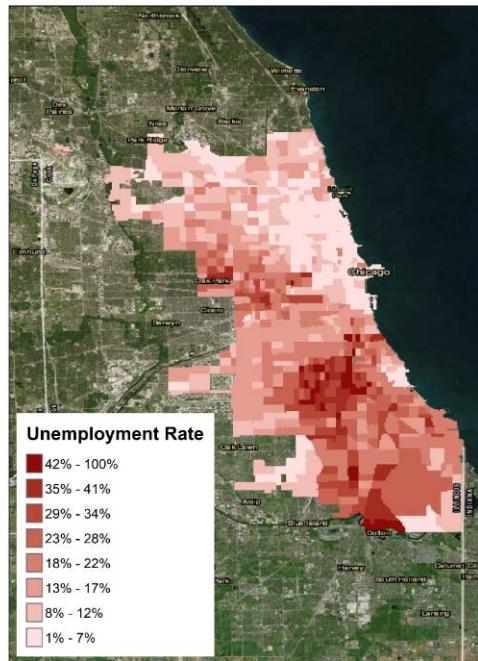


Source: Landsat-8 Satellite imagery,
2014 June – August average

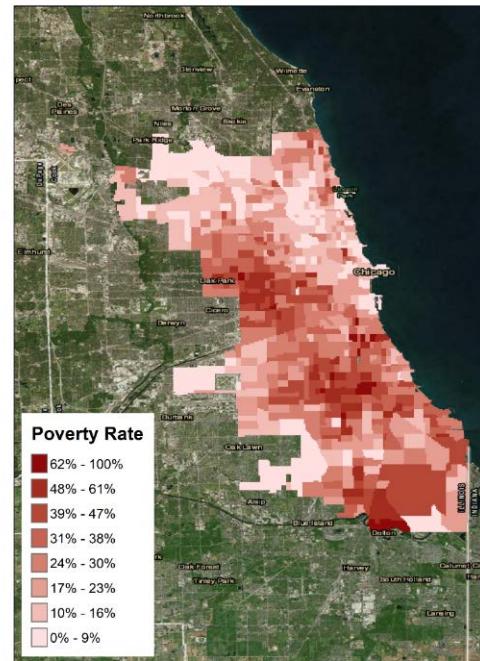


Source: Jarlath O'Neil-Dunne

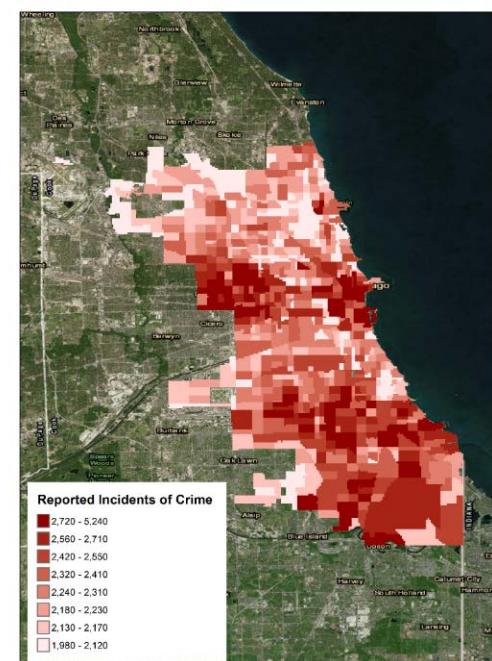
Vulnerability Indices in Chicago



Source: American Community Survey
5-year Estimation: 2010 - 2014

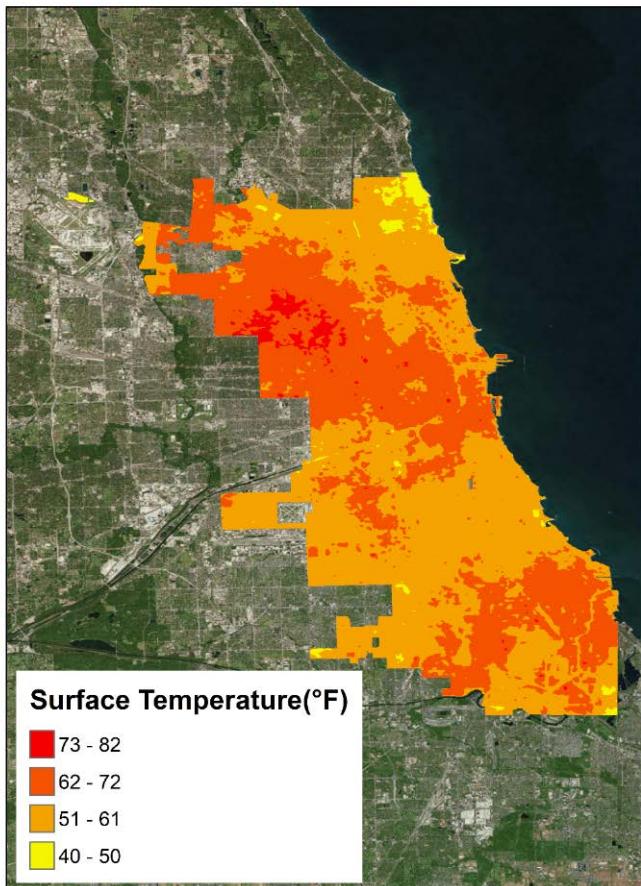


Source: American Community Survey
5-year Estimation: 2010 - 2014

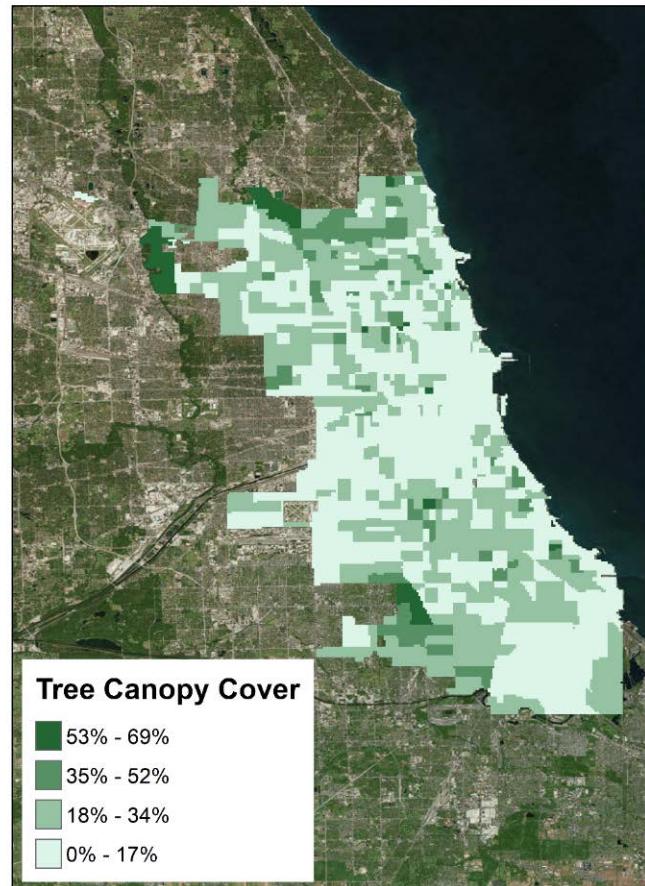


Source: <https://home.chicagopolice.org/> (The ClearMap)
<https://data.cityofchicago.org/> (GIS map)

Surface Temperature and Tree Cover



Source: Landsat-8 Satellite Imagery:
2014 June – August average



Source: Jarlath O'Neil-Dunne

Chicago Sun-Times

35¢

Chicago/ Suburbs
50¢ Elsewhere

COOLER Pages 2, 40

MONDAY, JULY 17, 1995

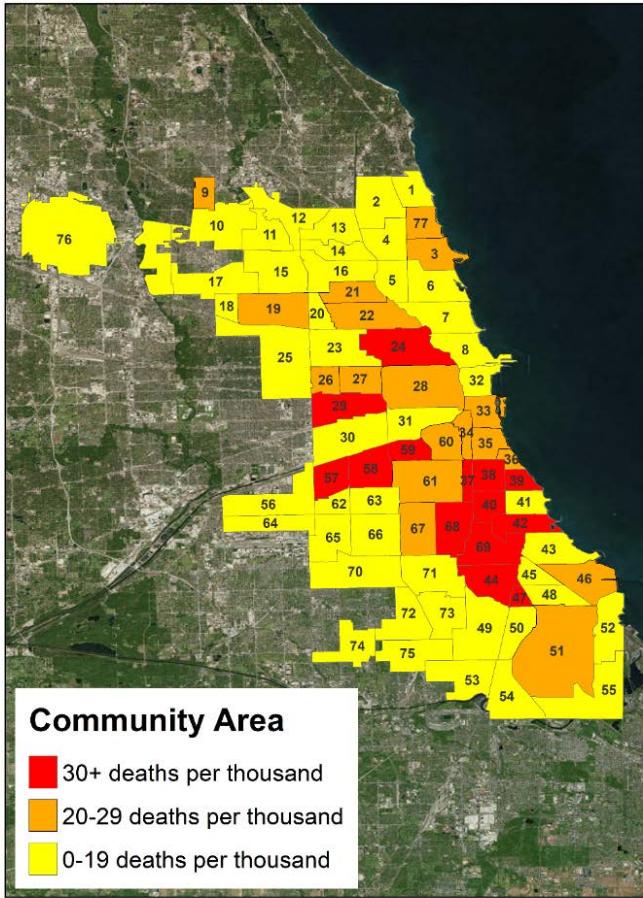
Late Sports Final

HEAT TOLL COULD HIT 300



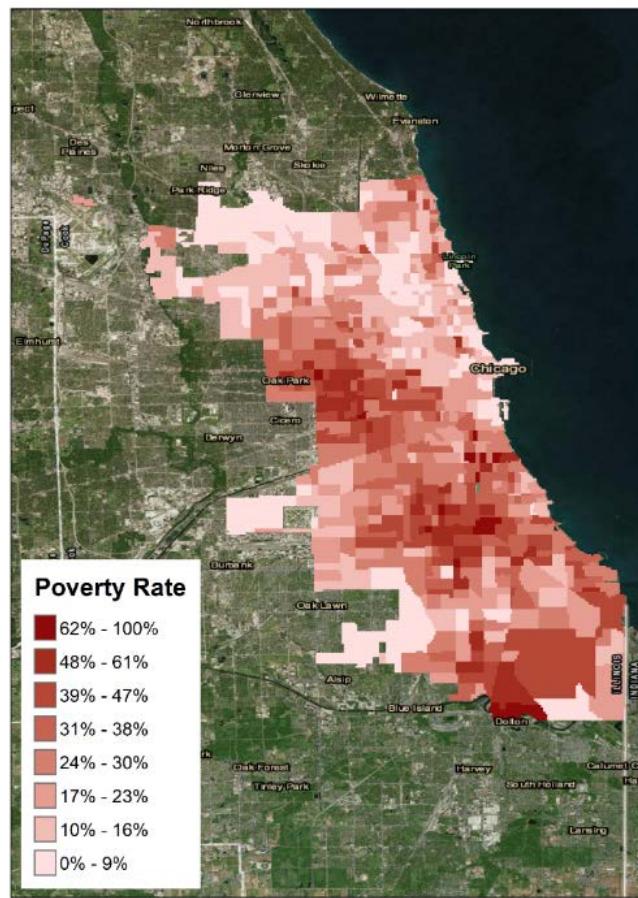
Heat-related mortality in Chicago, 1995

1 ROGERS PARK
 2 WEST RIDGE
 3 UPTOWN
 4 LINCOLN SQUARE
 5 NORTH CENTER
 6 LAKE VIEW
 7 LINCOLN PARK
 8 NEAR NORTH SIDE
 9 EDISON PARK
 10 NORWOOD PARK
 11 JEFFERSON PARK
 12 FOREST GLEN
 13 NORTH PARK
 14 ALBANY PARK
 15 PORTAGE PARK
 16 IRVING PARK
 17 DUNNING
 18 MONTCLARE
 19 BELMONT CRAGIN
 20 HERMOSA
 21 AVONDALE
 22 LOGAN SQUARE
 23 HUMBOLDT PARK
 24 WEST TOWN
 25 AUSTIN
 26 WEST GARFIELD PARK
 27 EAST GARFIELD PARK
 28 NEAR WEST SIDE
 29 NORTH LAWNDALE
 30 SOUTH LAWNDALE
 31 LOWER WEST SIDE
 32 LOOP
 33 NEAR SOUTH SIDE
 34 ARMOUR SQUARE
 35 DOUGLAS
 36 OAKLAND
 37 FULLER PARK
 38 GRAND BOULEVARD
 39 KENWOOD
 40 WASHINGTON PARK
 41 HYDE PARK
 42 WOODLAWN
 43 SOUTH SHORE
 44 CHATHAM
 45 AVALON PARK
 46 SOUTH CHICAGO
 47 BURNSIDE
 48 CALUMET HEIGHTS
 49 ROSELAND
 50 PULLMAN



Source: Eric Klinenberg,
 "Heat Wave: A Social Autopsy of Disaster in Chicago"

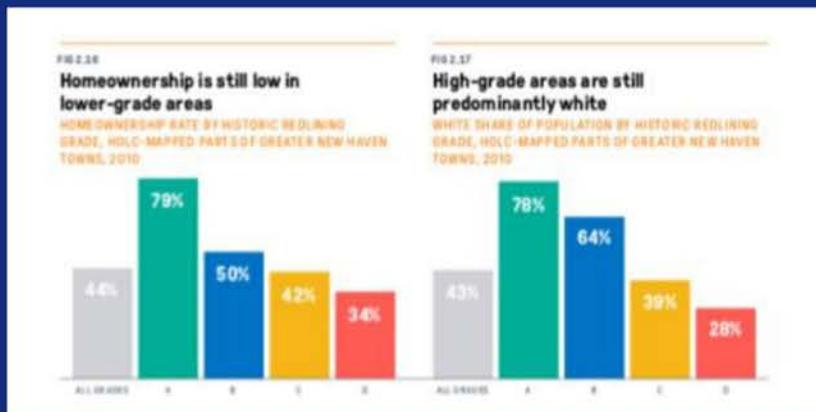
51 SOUTH DEERING
 52 EAST SIDE
 53 WEST PULLMAN
 54 RIVERDALE
 55 HEGEWISCH
 56 GARFIELD RIDGE
 57 ARCHER HEIGHTS
 58 BRIGHTON PARK
 59 MCKINLEY PARK
 60 BRIDGEPORT
 61 NEW CITY
 62 WEST ELDSON
 63 GAGE PARK
 64 CLEARING
 65 WEST LAWN
 66 CHICAGO LAWN
 67 WEST ENGLEWOOD
 68 ENGLEWOOD
 69 GREATER GRAND CROSSING
 70 ASHBURN
 71 AUBURN GRESHAM
 72 BEVERLY
 73 WASHINGTON HEIGHTS
 74 MOUNT GREENWOOD
 75 MORGAN PARK
 76 OHARE



Source: American Community Survey
 5-year Estimation: 2010 - 2014

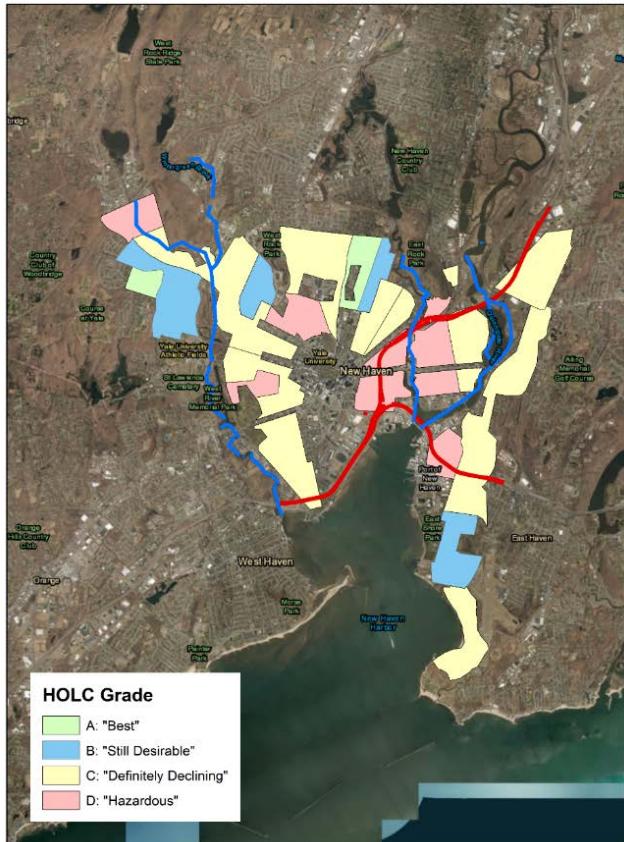
Redlining in New Haven

The legacies of redlining are still present today, affecting homeownership and wealth.

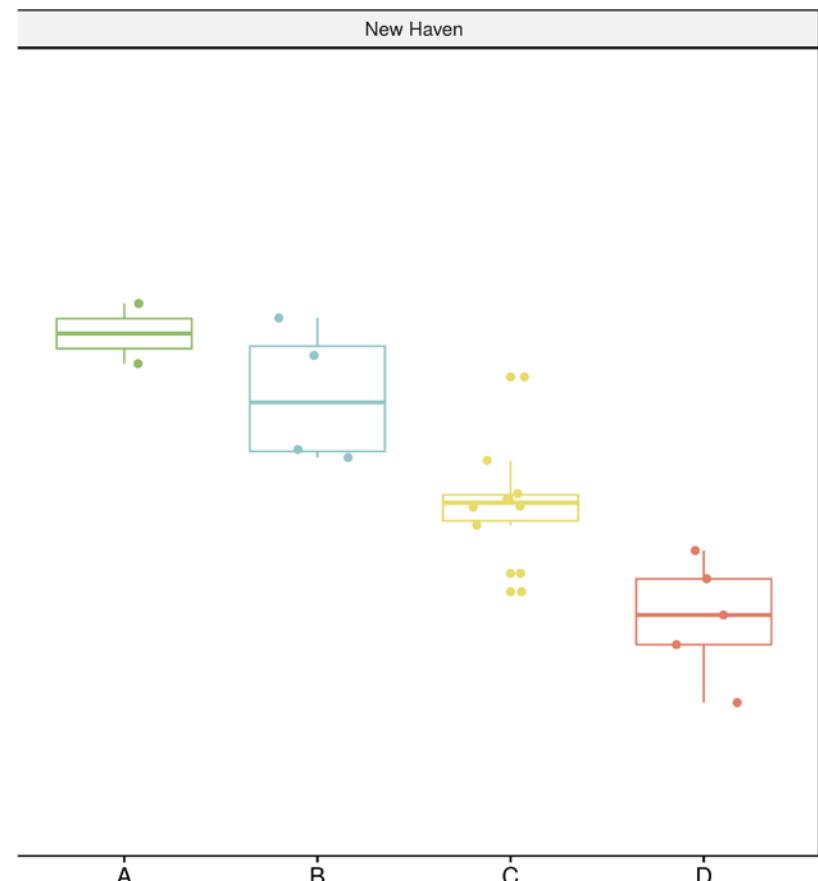


SOURCE: Data Haven

Homeowner Loan Corp. Grade



HOLC Grade & Tree Cover



Source: (1) <https://dsl.richmond.edu/panorama/redlining/#loc=4/36.71/-96.93&opacity=0.8> (2) Dexter Locke, personal communication



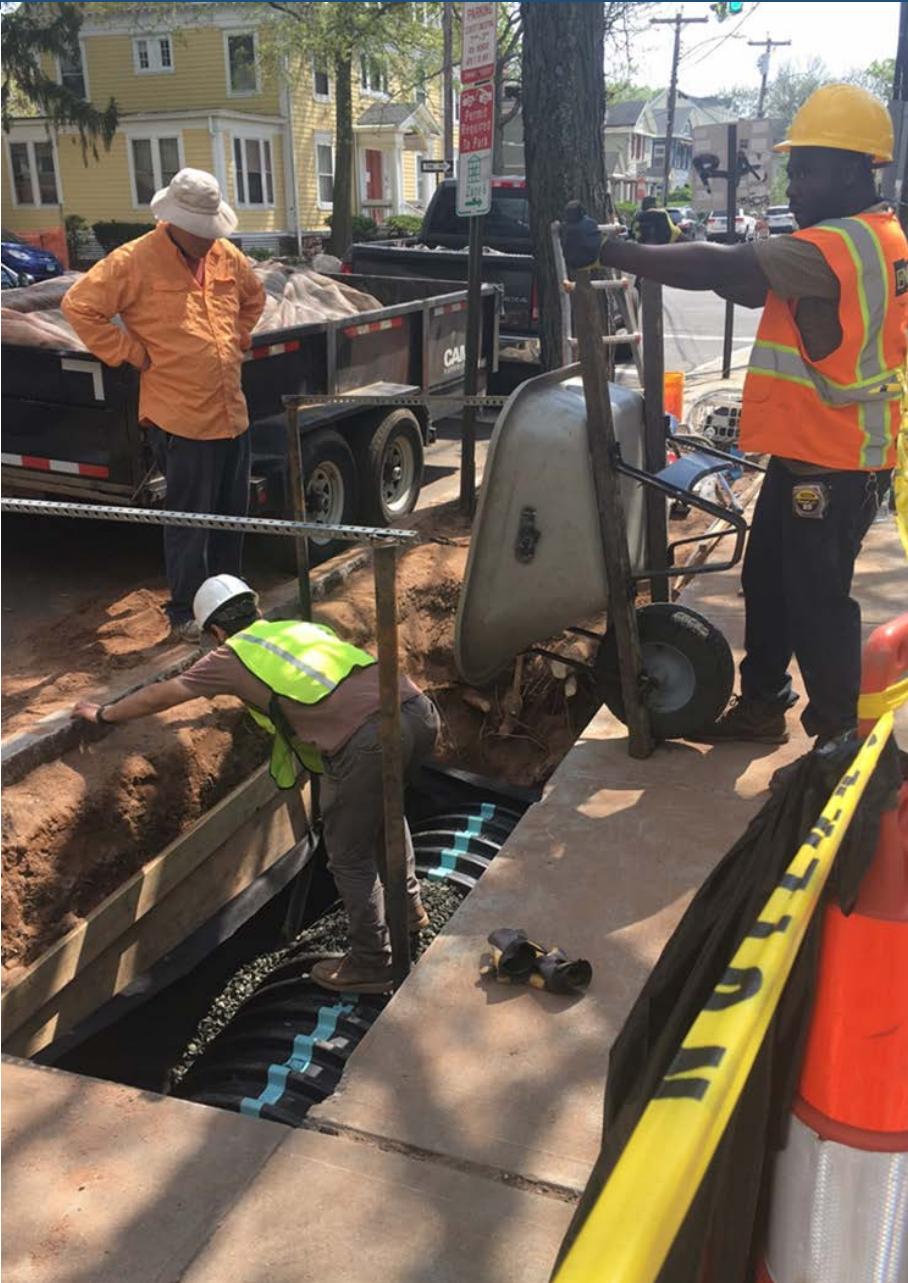
Yale SCHOOL OF FORESTRY & ENVIRONMENTAL STUDIES



Trees planted by teams made up of Yale graduate and undergraduate interns, high school students, and adults with history of incarceration



Yale SCHOOL OF FORESTRY & ENVIRONMENTAL STUDIES



Contributing collaborators

- Dr. Jarlath O'Neil-Dunne¹
- Dr. Dexter Locke²
- Dr. Karen Seto³
- Yichen Yang³



¹ University of Vermont ♦ ² USDA Forest Service ♦ ³ Yale University