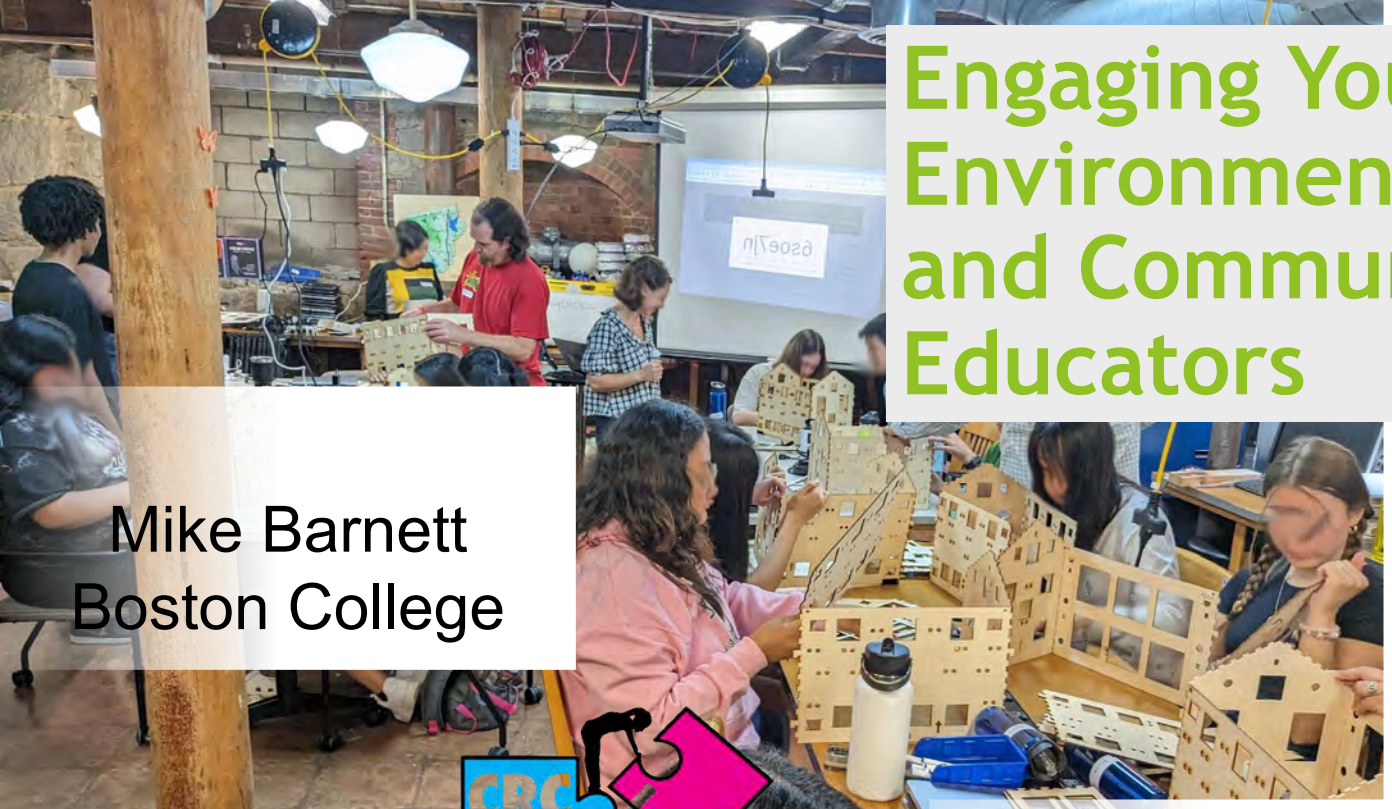
Engaging Youth as Environmental Justice and Community Educators



Mike Barnett
Boston College

A Collaborative Effort with youth

An Anonymous Foundation

Boston Scientific Foundation

Cummings $30 MILLION GRANT PROGRAM

Constellation.

LASELL UNIVERSITY

CHARLES RIVER MUSEUM of INDUSTRY & INNOVATION

EDC Education Development Center, Inc.

NSF

Helen Zhang (Learning Sciences)
Avneet Hira (engineering)
Glen Gaudette (engineering)

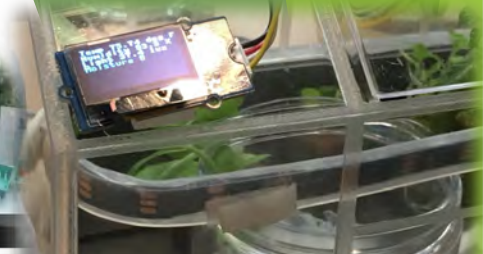
https://charlesrivercollab.org/

BOSTON COLLEGE ENGINEERING

CRC Charles River Collaboratory

Context of the work

- For 20 years youth have been engaged in environmental and STEM projects in an out-of-school in Waltham, throughout Mass, China, & India
- Every student in WPS since 2010 has probably participated in at least one project either in school or out-of-school
  - Food Justice through hydroponics/aquaponics
  - **Urban Tree Study – Identified every street in Boston (only 43,000!! In 2008)**
  - **Heat Island, Air Quality, Urban SoundScapes**
  - Urban Planning and Social Justice (partnered with ESRI, Placeways, MAPC)
  - Coding: Automated Farming Gardens, Smart Mini-Greenhouses
  - Transparent Soil
  - Tissue Engineering – growing artificial hearts from plant scaffolds



NSF Stories

Soil-free farming prepares next generation for Green Energy future

cramped city, growing a garden is a luxury. For son
feet of space is all they need to grow up to 40 p
llege, with funding from NSF, is teaching teen

ces Governments Ca

ch

cts like Smart Citizen and Air Quality Egg promise a future of cheap
quality sensors–and a world where we know what's happening every

Beijing elementary school students are back in the classroom. And whether they know it or not, the education is about to filled with grueling exams that will determine their future.

"Memorizing a lot of information doesn't necessarily lead to creativity or problem solving skills," says Boston College Professor Mike Barnett.

The Chinese government has recruited Barnett to help.

"They're seeing a lot of what their students produce is kind of imitation in nature, as opposed to innovation in nature," he says.

Barnett doesn't use textbooks. Instead, he teaches students to think and reason using real-life problems. His methods are used in 500 schools across the U.S.

MINUTE READ

What we are striving to…

- Elevating youth voices as leaders, changemakers, and mentors. In this way youth are designing and transforming the future of their communities through their work by creating …

https://charlesrivercollab.org/

Engage Youth and Communities in **transdisciplinary** Science and Engineering: Making STEM relevant

Real World Science

School Science

Actual Science

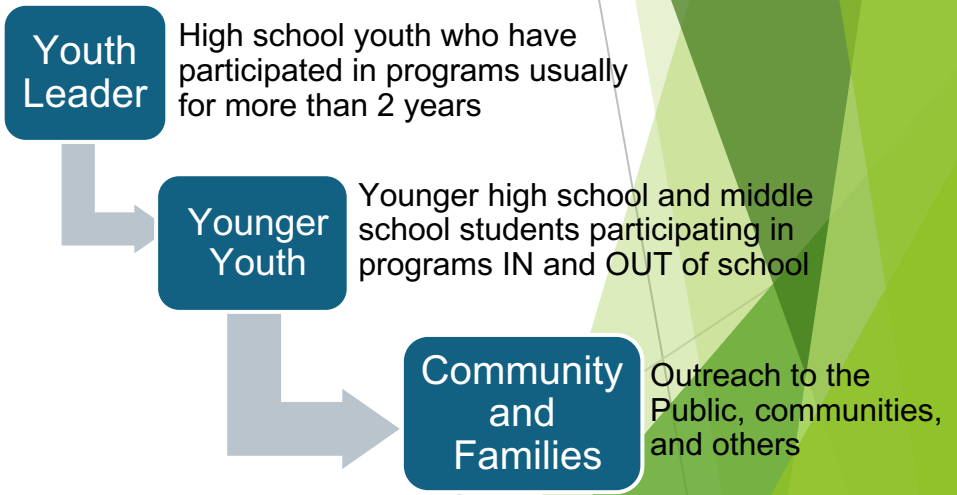
Much of how we learn science is discipline based, but actual science is very transdisciplinary….

Youth engaged in tissue engineering - growing quail cells on decellularized basil leaves

Create A Community of Learners

- Peer Mentoring: Build Capacity of Youth to serve the Community
- Mentoring and apprenticeship are critical in shaping youth as change agents, as the latter role requires skills rarely taught in formal education.

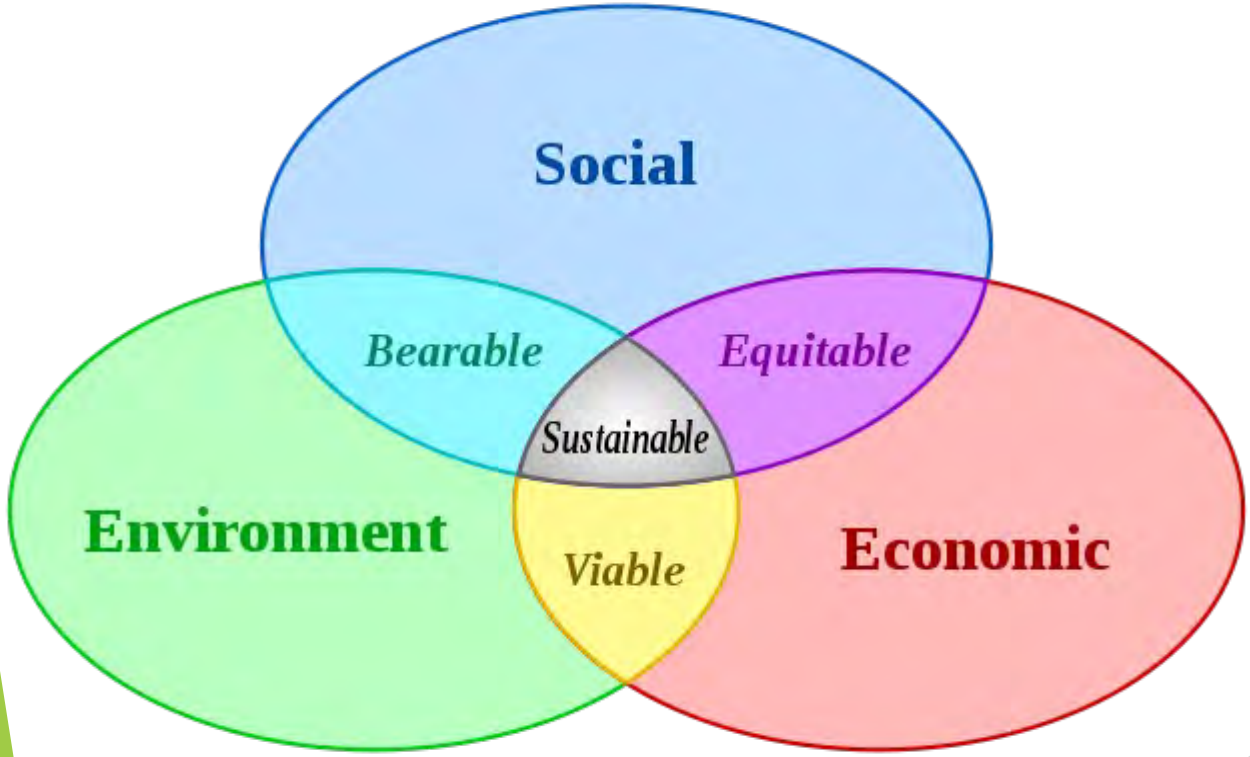
Elroy (pseudonym) - had no interest in STEM when joined us (8th grader, now a junior - Posse nominee and wants to study computer engineering). Always helps others. Many examples

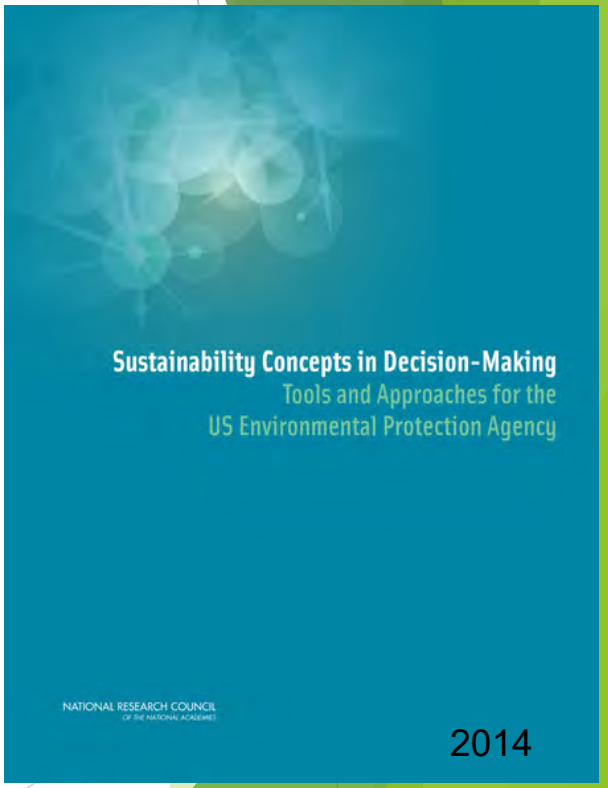


The Three Domains Model - Framework that youth engage their work with

International Union for Conservation of Nature

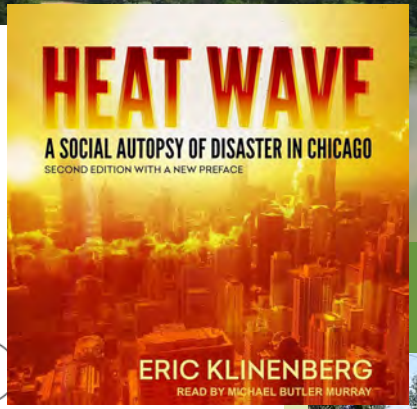
(Adams, Future of Sustainability)

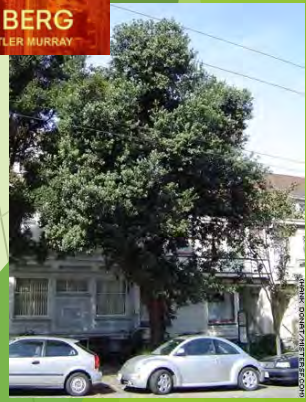




Benefits of Trees and Green Space in Urban Areas

- Save Energy
- Improve air quality
- Increase real estate values
- Increases time people spend shopping – shaded retail areas usually show a 10-20% boost in sales
- Increase sociological benefits
- Community awareness/building
- *Protect our water resources*
- *Reduce storm water runoff costs*
- *Has implications for green space in any city….*





What students do...

Collect Data: and figure out Carbon in Trees

Carbon in tree = 0.35 x Diameter of the tree + (.24 *Height of tree)

Carbon weighs 12 (u), and oxygen weighs 16 (u). Based on the CO_2 to C ratio, the weight of CO_2 in trees is calculated at 44/12 = 3.67. To calculate the weight of carbon dioxide stored in the tree, multiply the total carbon dioxide weight by 3.67.

So total Carbon Dioxide Sequestered is Carbon in tree * 3.67

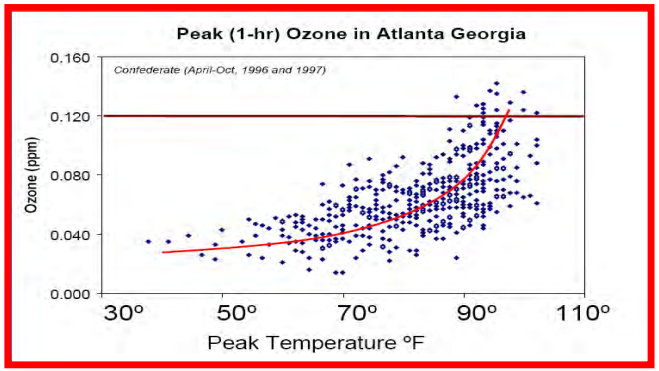
Perkins, M. (June 6, 2007). Urban Tree Project engages students in surroundings. Daily News Tribune. Available at http://www.dailynewstribune.com/education/x1689350349

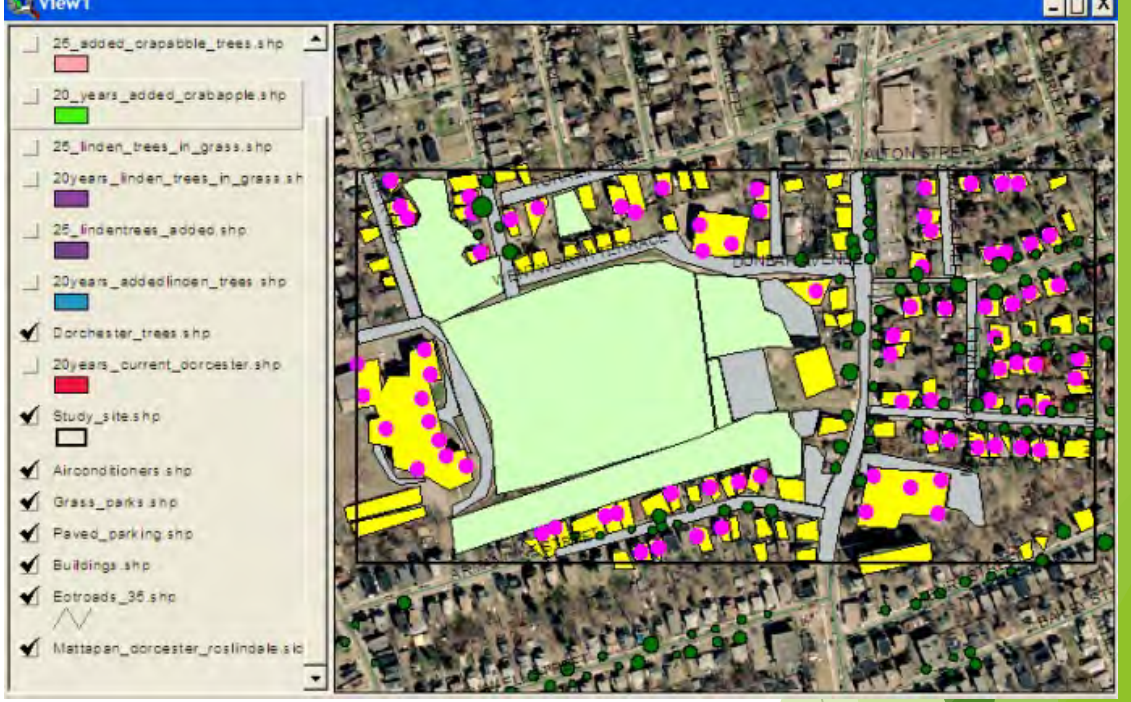
Planting trees are great…

- A healthy tree stores about 13 pounds of carbon annually -- or 2.6 tons per acre each year.
- An estimate of carbon emitted per vehicle mile is between 0.6 lb. CO_2/mi. – 1.2 lb. CO_2/mi.
  - An “average” car driven 26,000 miles will emit between 20,000 lbs CO_2 and 30,000 lbs. CO_2.
  - **one acre of tree cover** in the area can compensate for automobile fuel use equivalent to driving a car between **7,000 and 9,000** miles.
  - Arguing trees will fix climate change wrong approach… (helps but…)
  - It also **matters *a lot*** where you plant them…. you also get **a *lot* more services**

Very simple GIS:

Put in tree locations and run simulation





https://docs.google.com/spreadsheets/d/1c02BdQItzWrk68rVYTVgGzyVckD0U6ZZHV6qaVj6LnU/edit?gid=1070756879#gid=1070756879 (for easy use in schools)

https://mytree.itreetools.org/#/location

Get report out….

Residential Cooling Effects

Average Annual Cooling Cost per Home:		$600.00
Number of Homes:	122	
Savings from Trees:		$713.34
Savings from Roofs:		$0.00
Total Savings:		**$713.34**
Savings per Home:		$5.85
Kilowatt-hours Saved:	7,354.02	
KWHs Saved per Home:	60.28	
Carbon Generation Avoided:	293,887.99 lbs.	
Carbon Generation Avoided per Home:	2,408.92 lbs.	

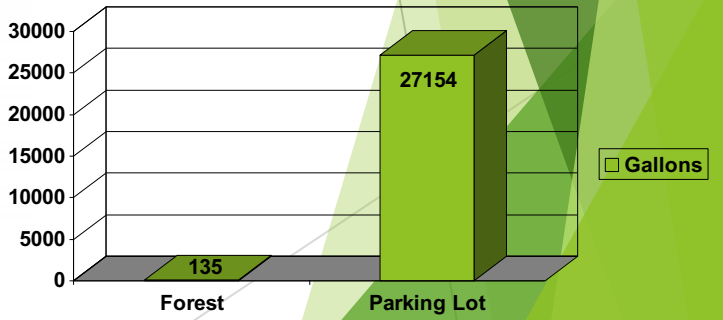
	Conditions: Current	w/o trees*	
Curve Number:	85.00	85.00	
Runoff (in.):	2.02	2.02	
Storage volume needed to mitigate the change in peak flow:	0.00		cu. ft.
Construction cost:	$2.00		per cu. ft.
Total	**$0.00**		

*Replaced by default landcover: Urban: Residential: 0.125ac Lots

Economic Benefit Summary

Annual Air Pollution Removal Savings:	**$29**
Annual Energy Savings:	**$713**
Annual Stormwater Savings*:	**$0**
Total Annual Savings:	**$742**

Runoff Generated by 1” Rainfall
over 1-acre parcel

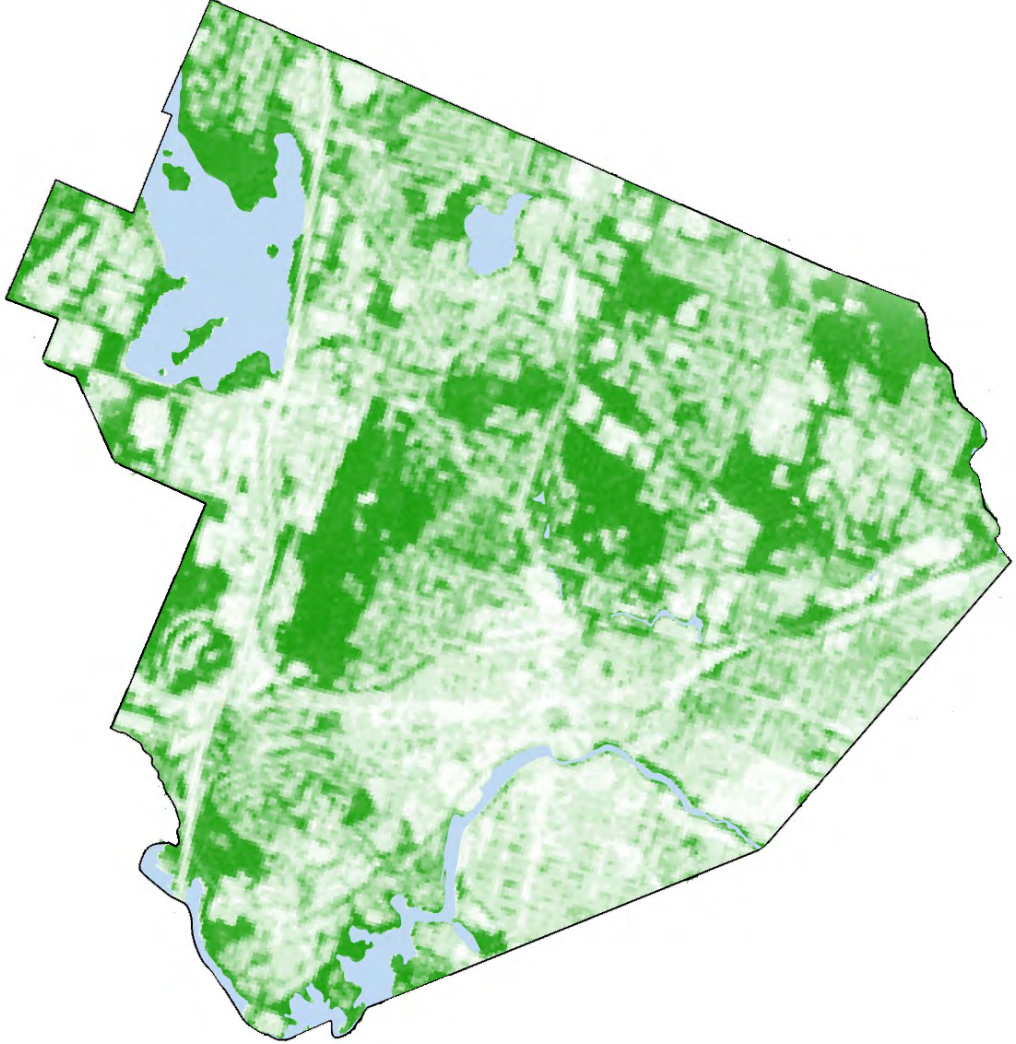


More sophistication… can explore patterns and data

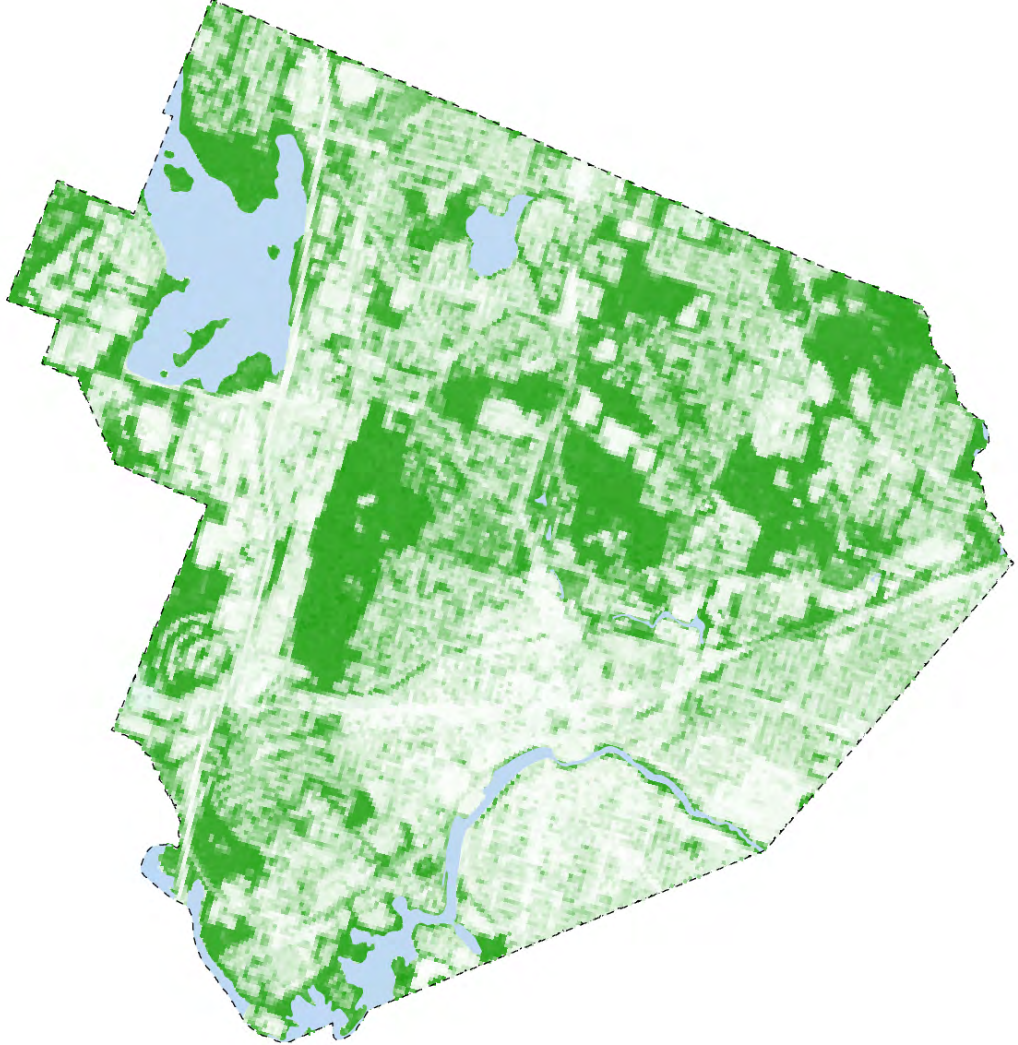
- Youth can examine a range of variables
- Black = Asphalt
- Green = Tree Cover
- Colors (Pink/Blue)= Buildings
- Blue = Water

2008 Tree Cover

- Darker Green means more tree cover

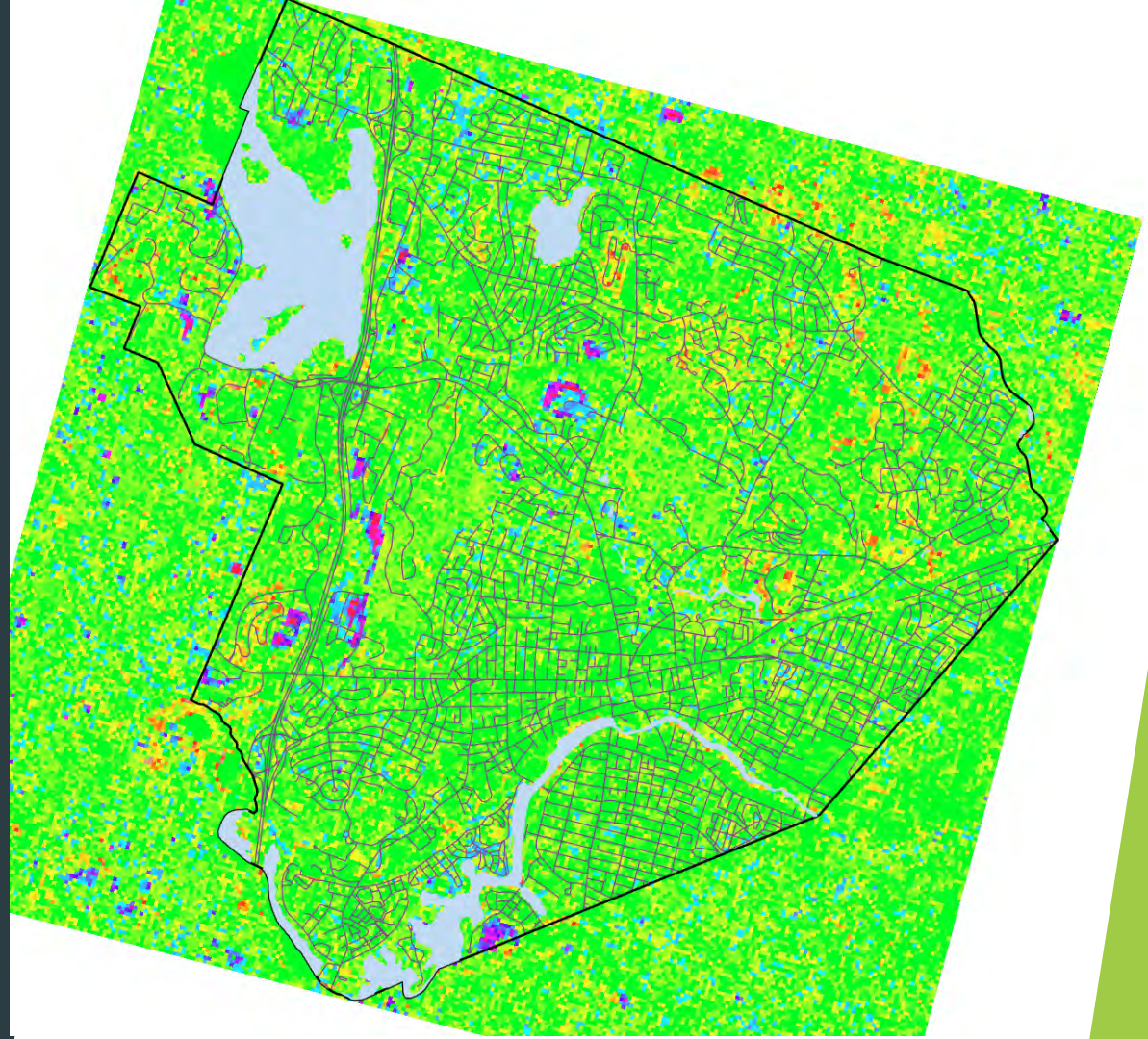


2021 Tree cover

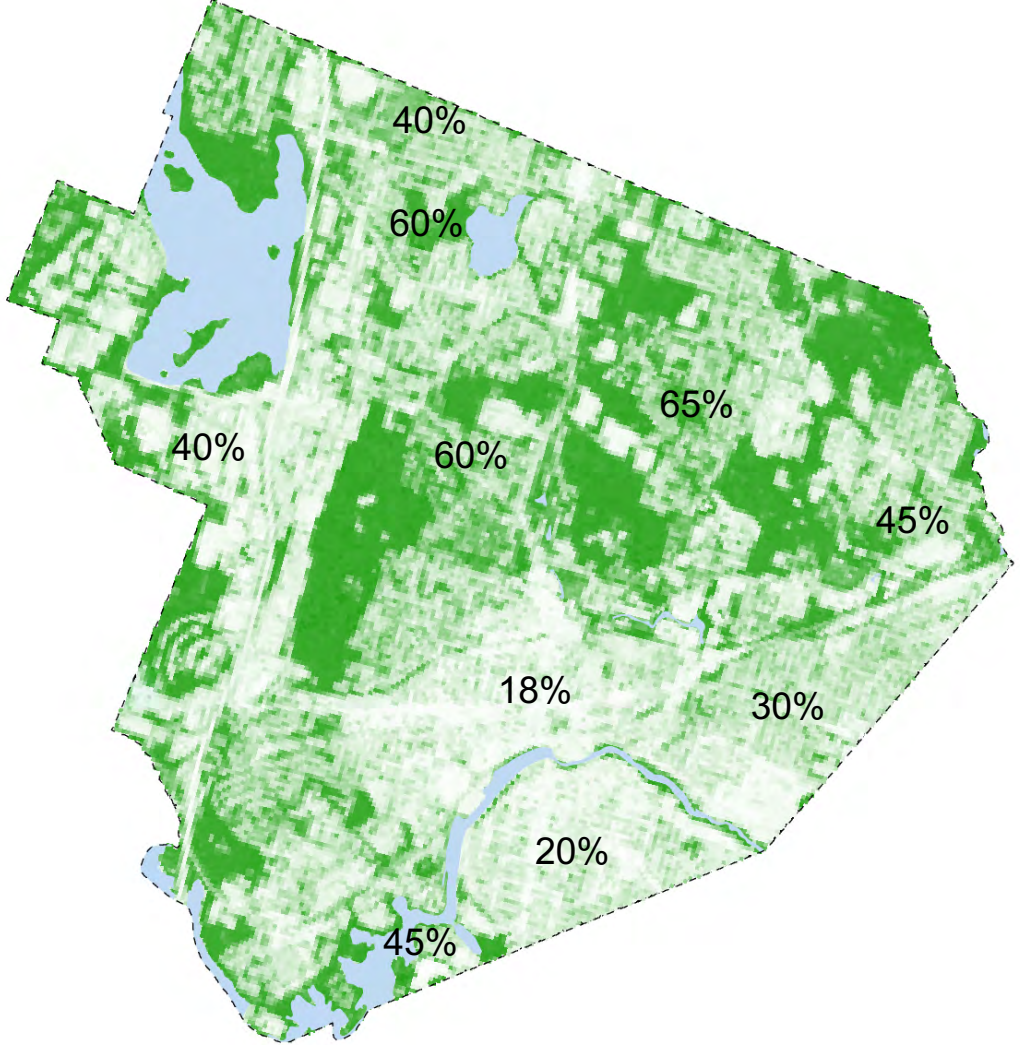


Compare the two years

- Purple areas mean a significant loss of trees (80%+)
- Blue = major loss (60%+)
- Yellow and Red = 30%+
- Green areas mean little change

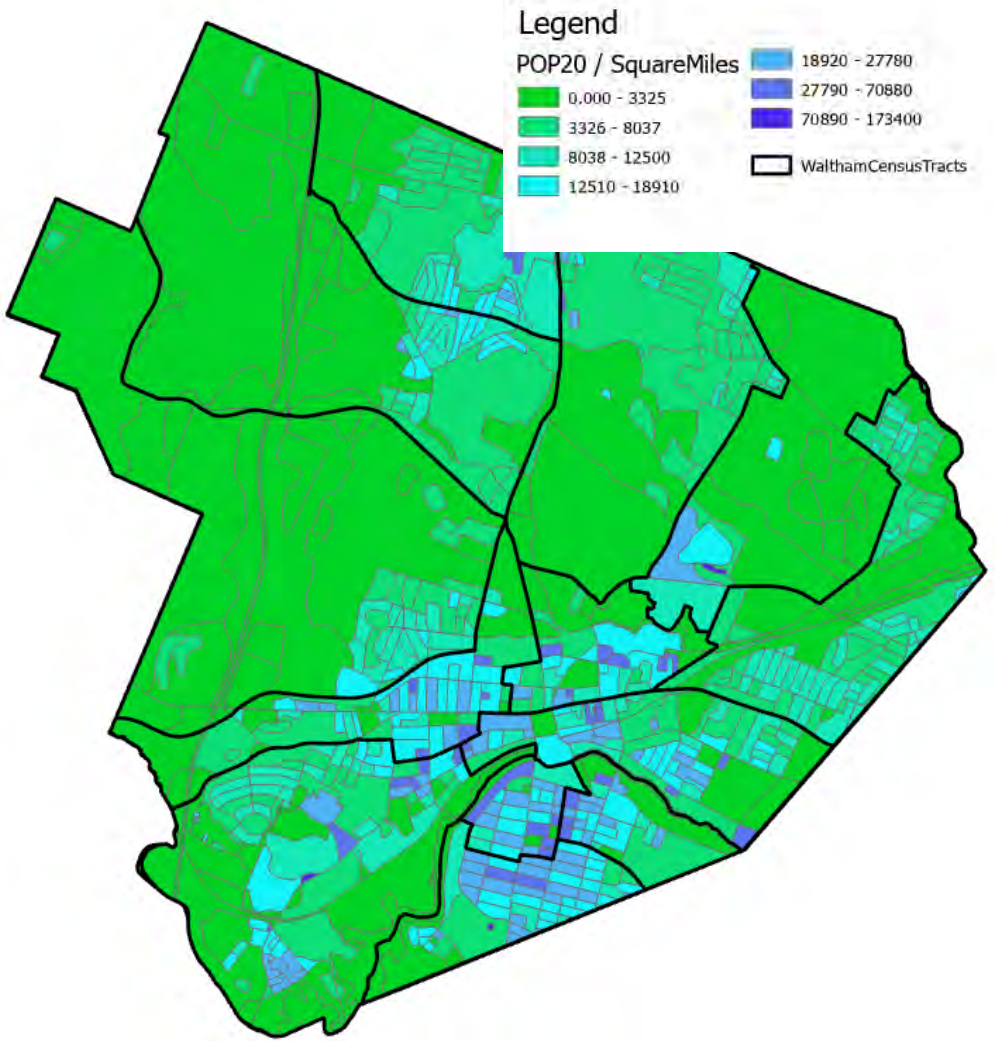


- Most urban areas should be at target 40% canopy cover to mitigate heat island impacts (American Forests)
- Waltham has it tree cover canopy exactly backwards for mitigating heat island effects/air quality in the city/climate change reduction impacts…

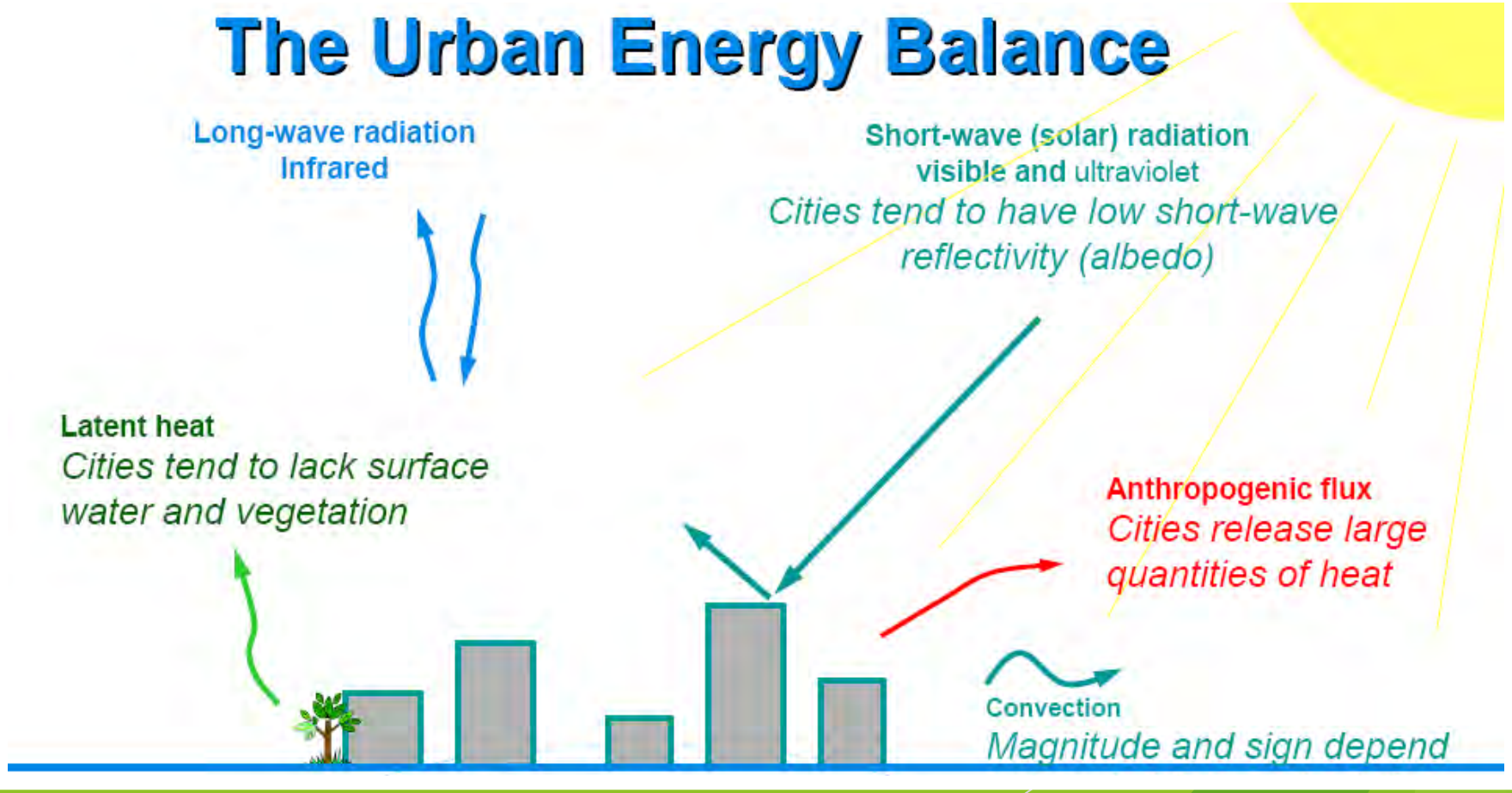


Population density is a lot higher in blocks with fewer trees

- Population density per square mile

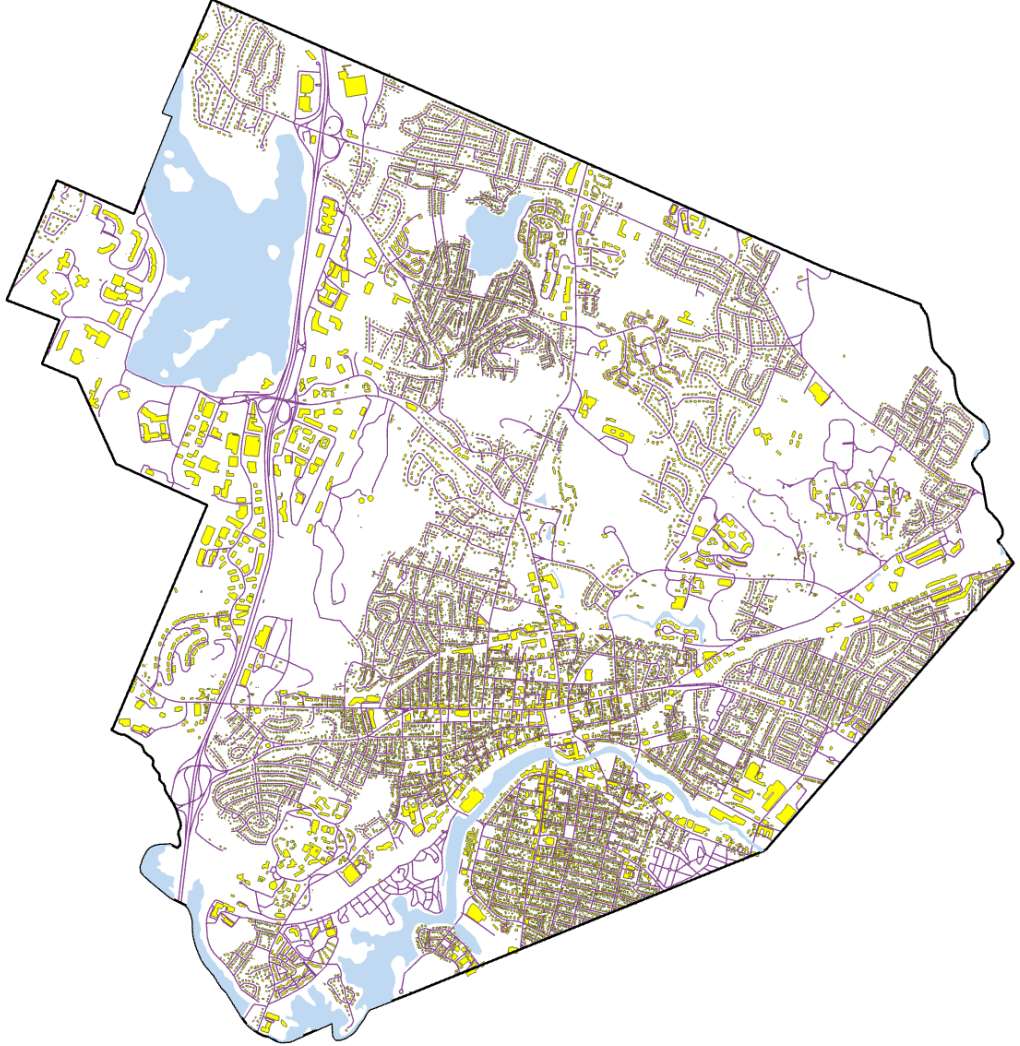


The Urban Energy Balance



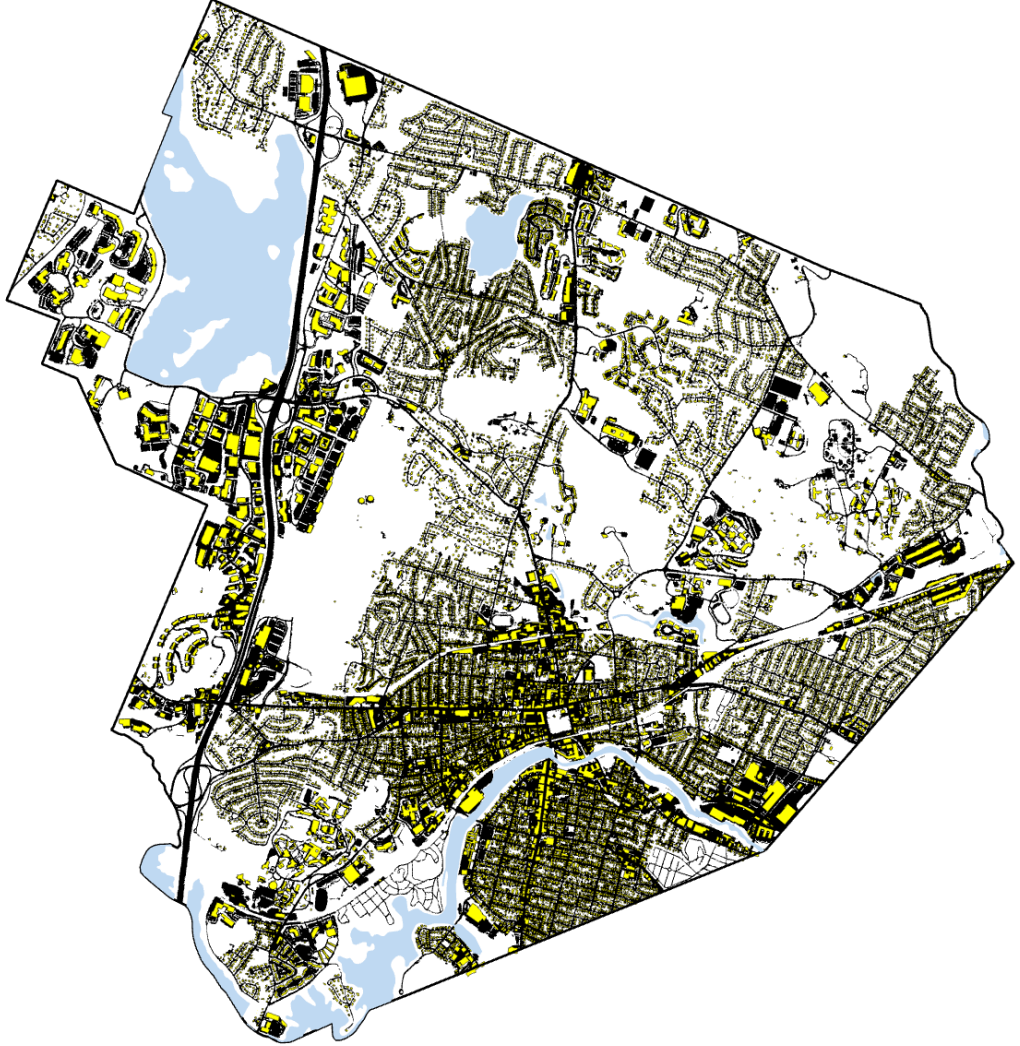
Lets revisit the Built City

- Buildings and Roads in City
- Yellow = Building Footprints
- Purple = Roads



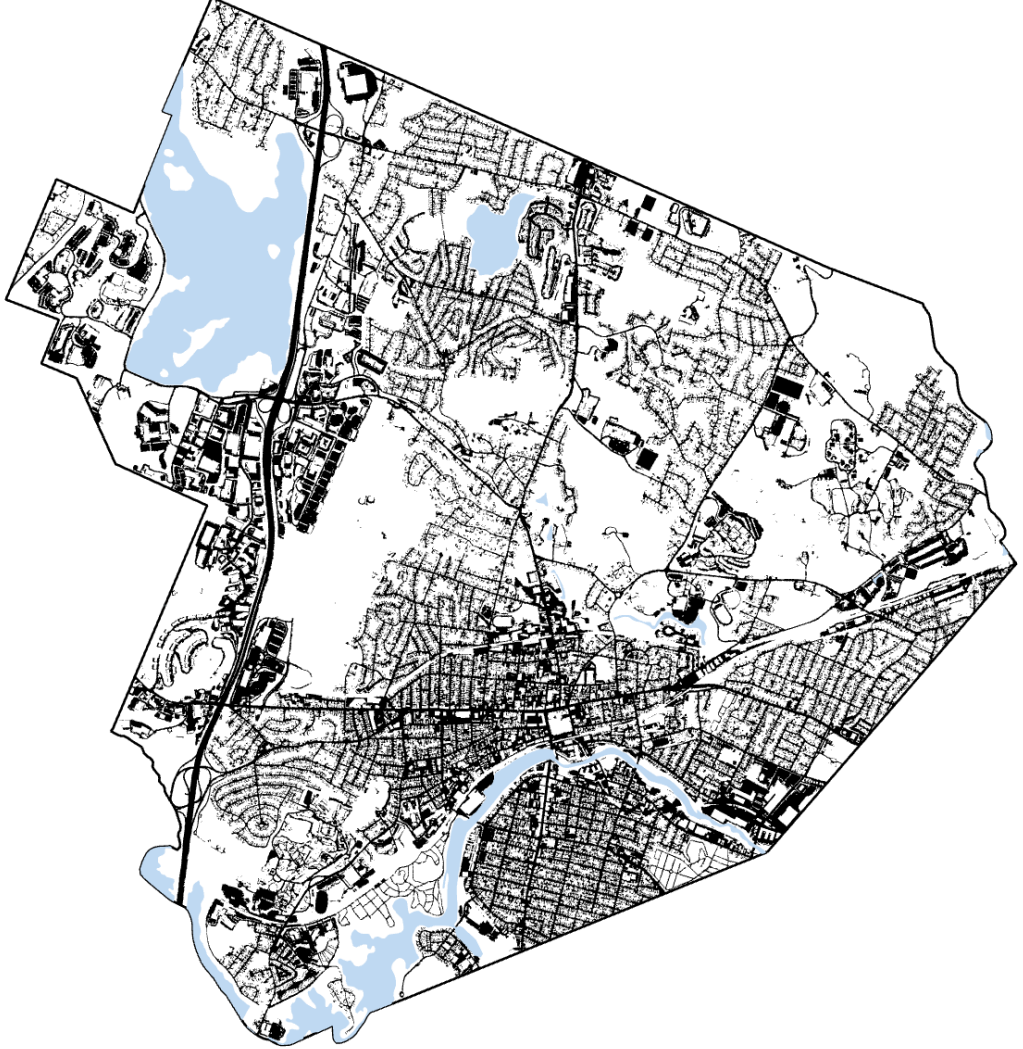
Lets add some Asphalt

- Paved areas/Impervious areas
- Black = Roads/paves areas
- Yellow = Building footprints

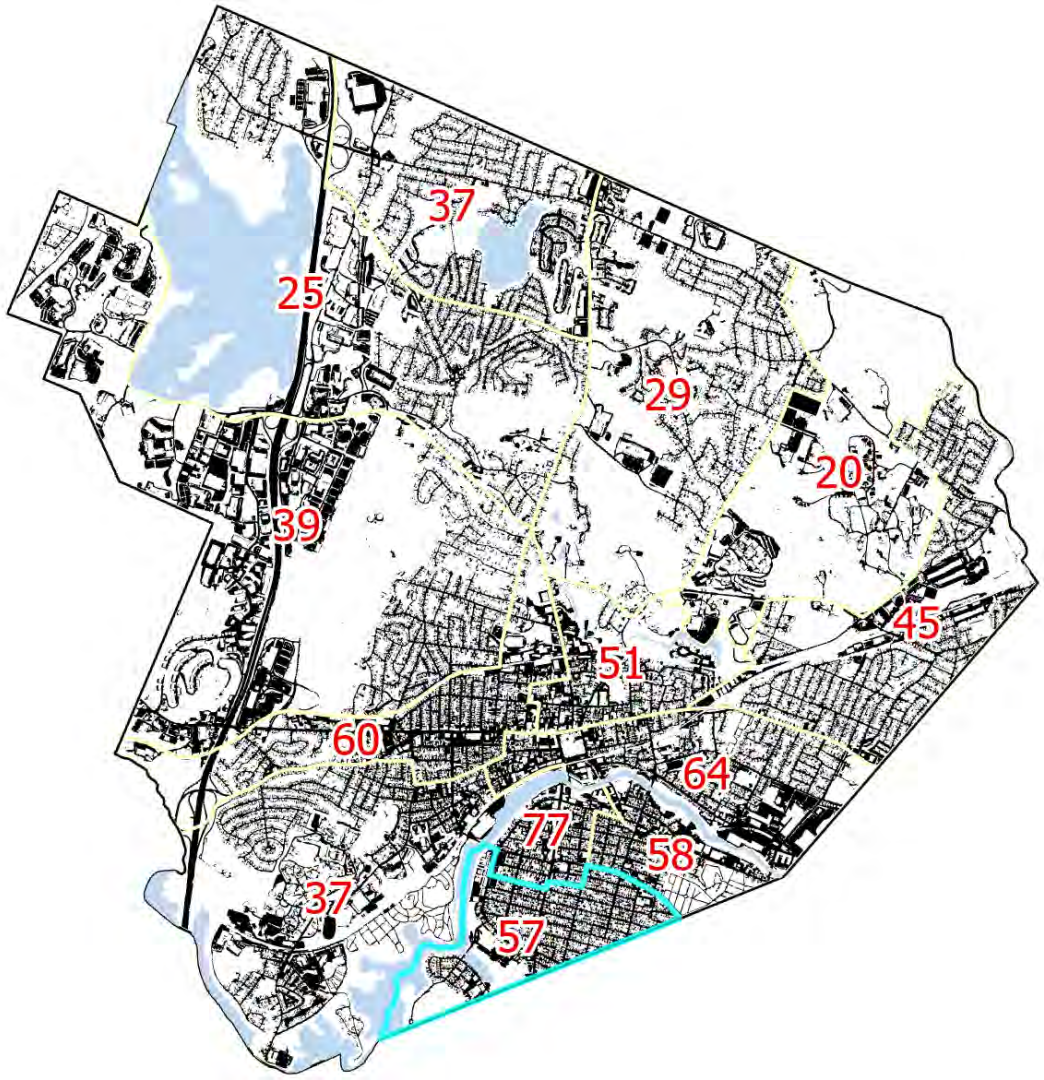


Lets take out the buildings

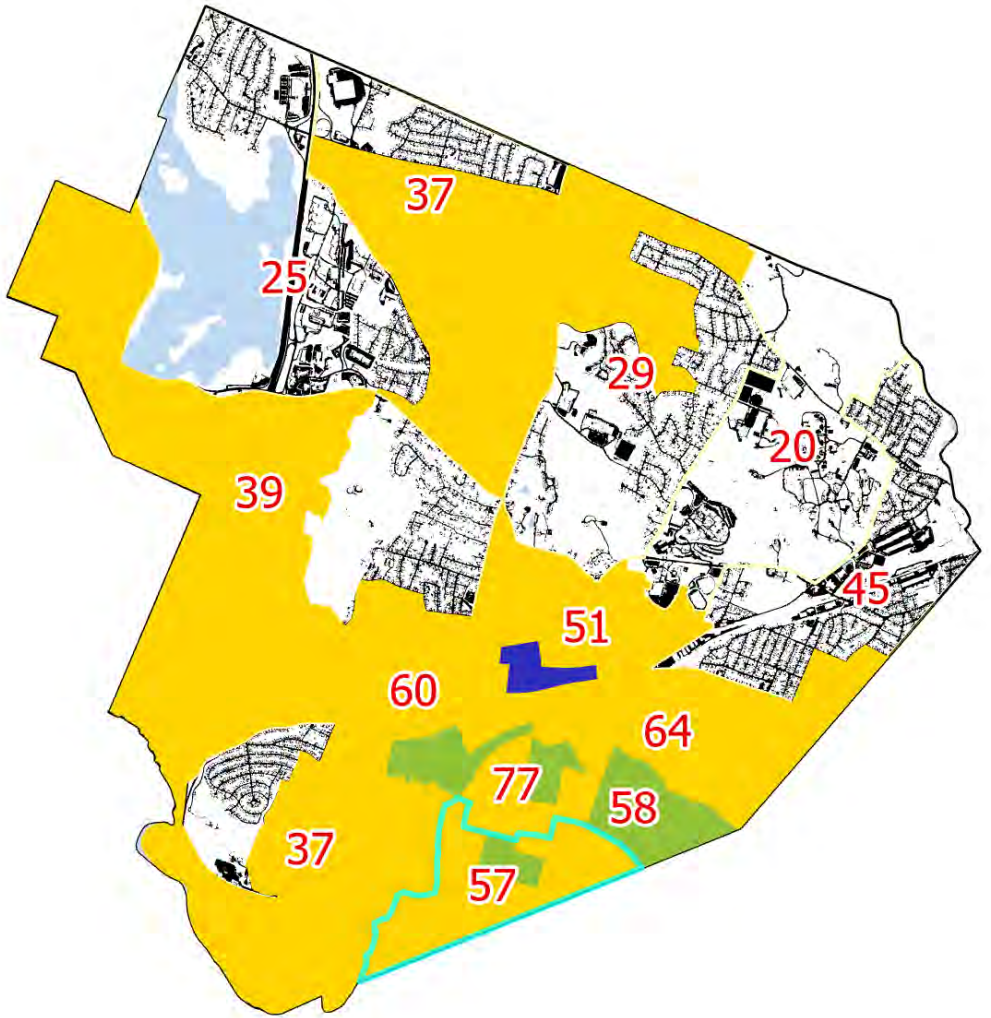
- Taking out the buildings leaves us just with roads and paves areas and other types of impervious surfaces



- Then you can map to the census tracts, calculate areas and get a good idea of how much of the tract is impervious (minus the buildings) – mostly **parking** and roads!

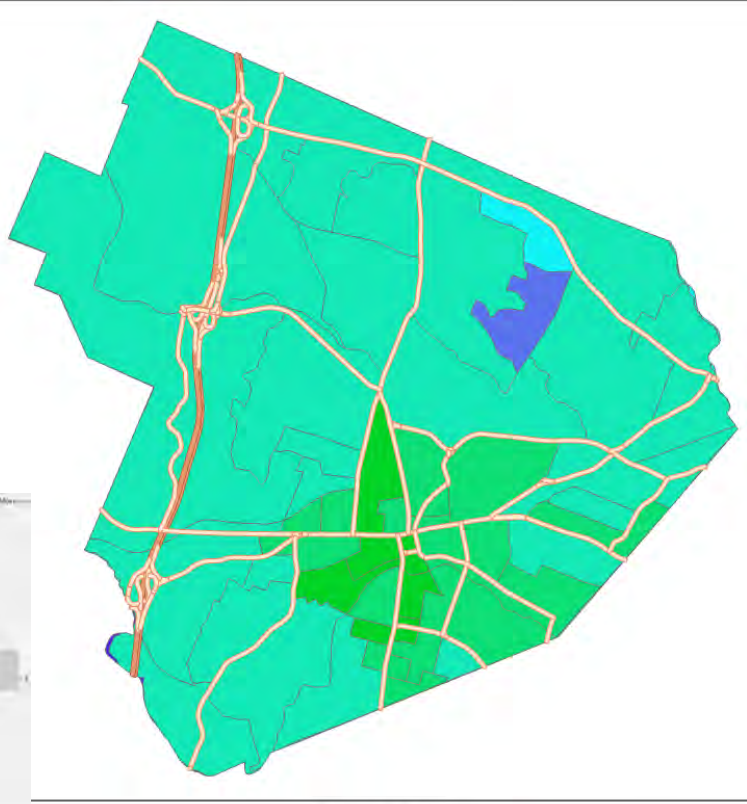


- Why this matters….
- Areas with more paved surfaces
  - More impacted Environmental Justice Populations
  - Yellow = Minority populations
  - Green = Minority + Low income
  - Blue = Minority+Income+English Isolation
  - These same areas also have less access to green space and trees



Some shifts in median income

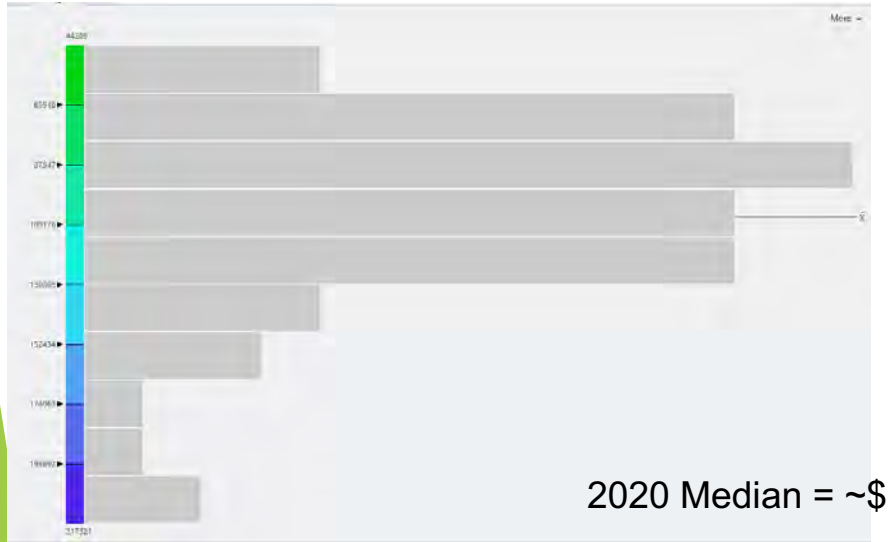
- 2011 Median Household Income (normed to 2019)



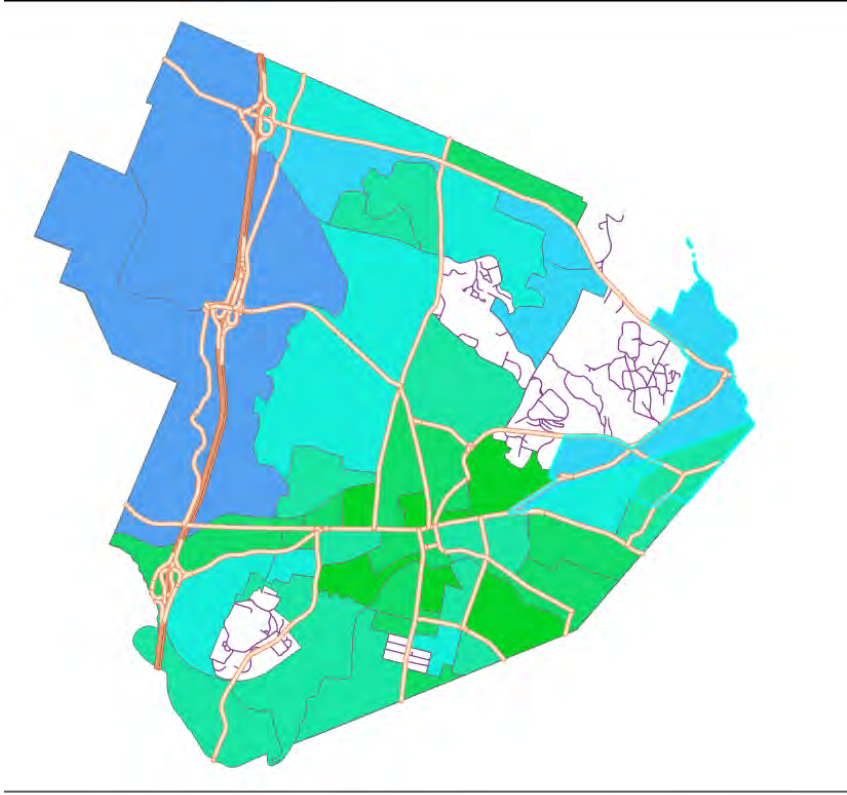
2011 Median = ~$74K

Median Income Levels

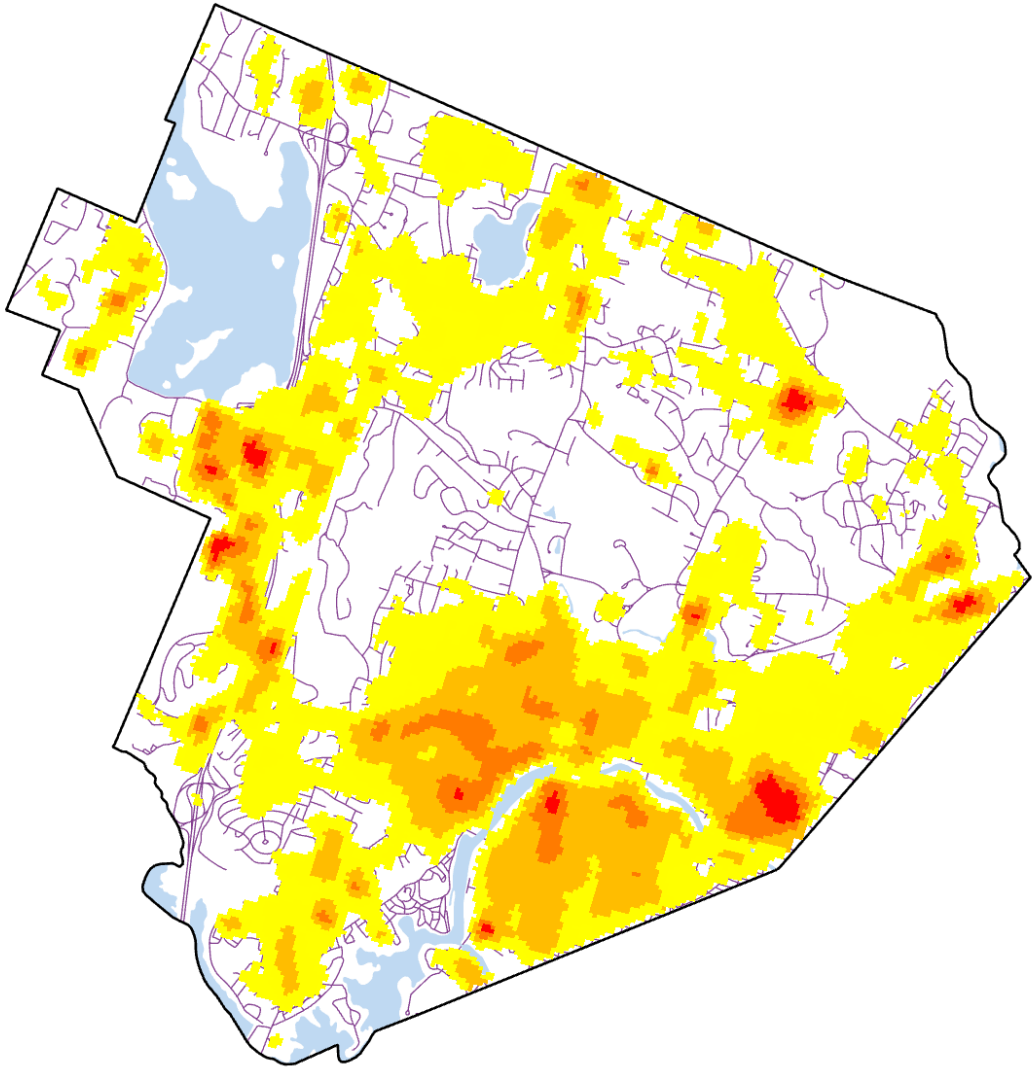
- Median Income Household Levels (2020, normed to 2019)
  - The white areas are not complete in the data set
  - Still missing data from some areas…. So story not in yet… more variation in though



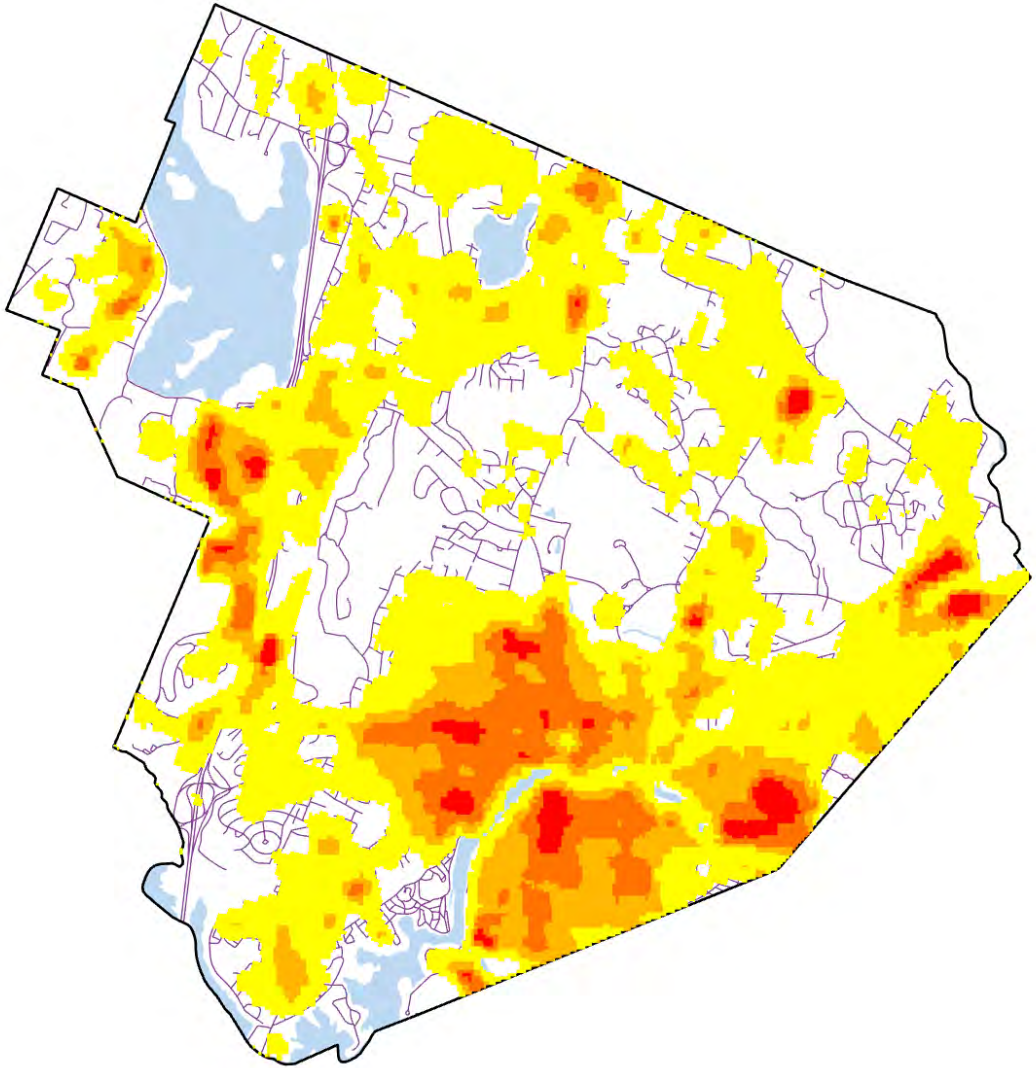
2020 Median = ~$112K



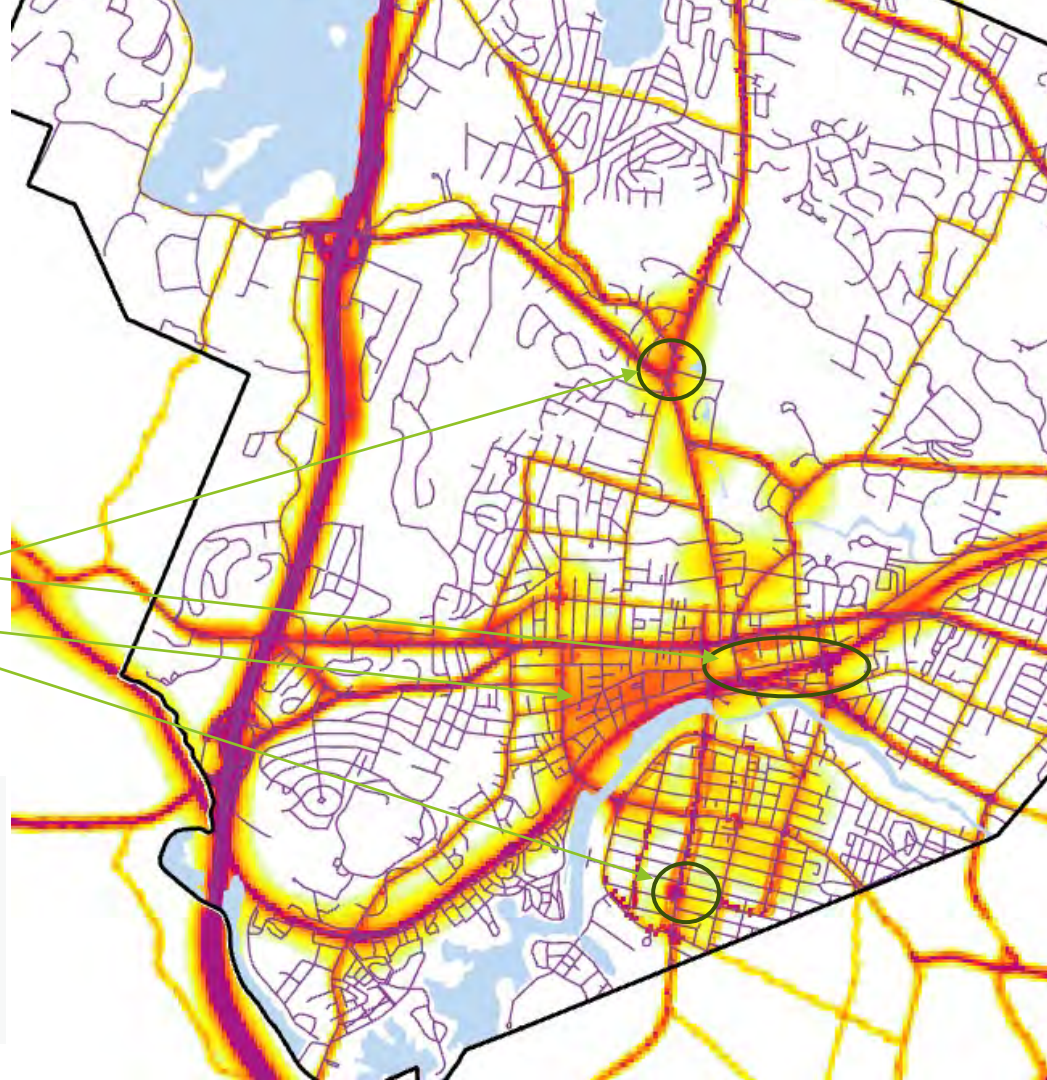
- 2019 Temp – over 1.5C above daily average (July/August)
- Red areas 70%+
- Yellow were most 50%+
- Orange about 30% of days
- White about the same



- 2023 Temp – over 1.5C above daily average, Summer (July/August)
- Red areas 70%+
- Yellow were most 50%+
- Orange about 30% of days
- White about the same



- Combine with Traffic data from the Department of Transportation and sensors
- For the month of Sept 2023
- Hotspots for noise
- Averaged more than 90 db for more than 1 hour

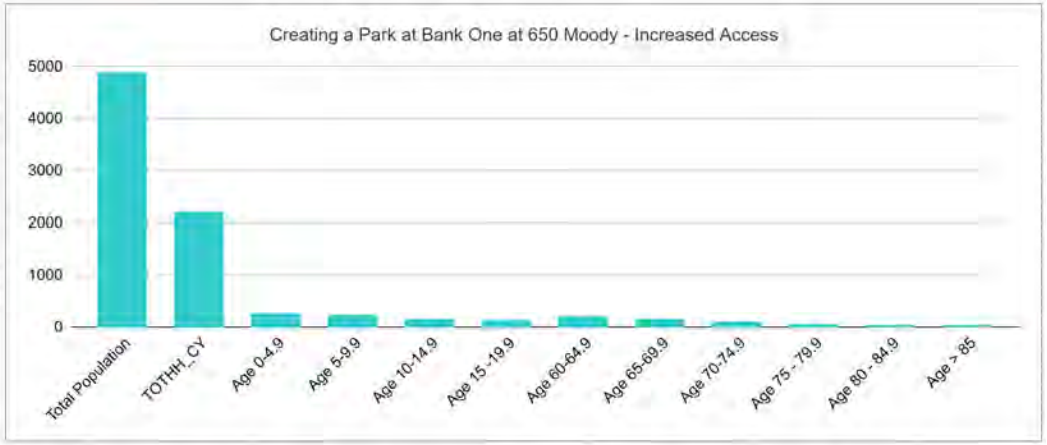


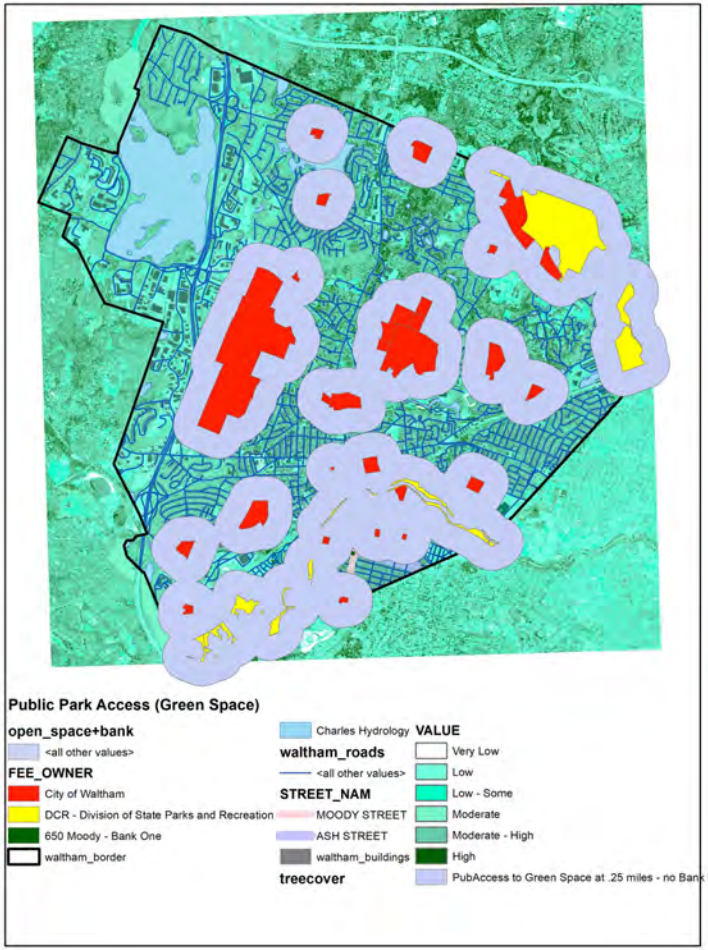
Bank One Analysis

Instead of a parking lot – which violates nearly all good urban planning policy (every should read Shoop and more recently Grabar)

What if you put a park there?

People are more likely to use a park if ¼ of mile or less walking





Longitudinal Impact

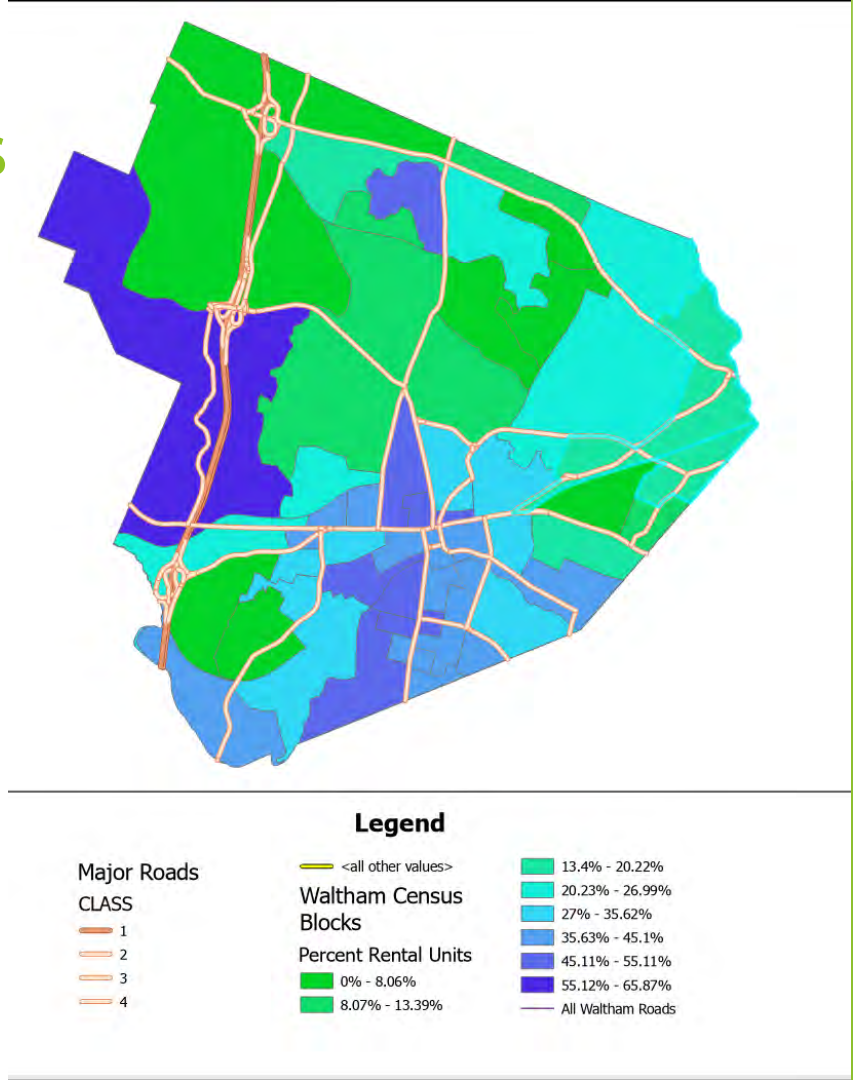
- Been doing the work for a while about 20 years (6500 youth who participate for more than 1 year in OST programs)
- Most youth participate for more than 3 years - learned it takes at 2 (usually three years to re-ignite that spark to pursue a STEM field)
- OST programming - 85 % of youth go to college, 20 Gates Scholars, 15 Posse scholars, 60% study STEM in college
- In classrooms - seen significant gains for those youth who are in the lower ⅓ regarding their identity toward STEM and efficacy toward coding
- Be on the lookout – May 10th, 2025, National STEM day, with CRMII and the tech companies (Boston Dynamics, Thermo-Fisher, iRobot, Spark Photonics, etc.. And the youth alumni….)

Special Thanks

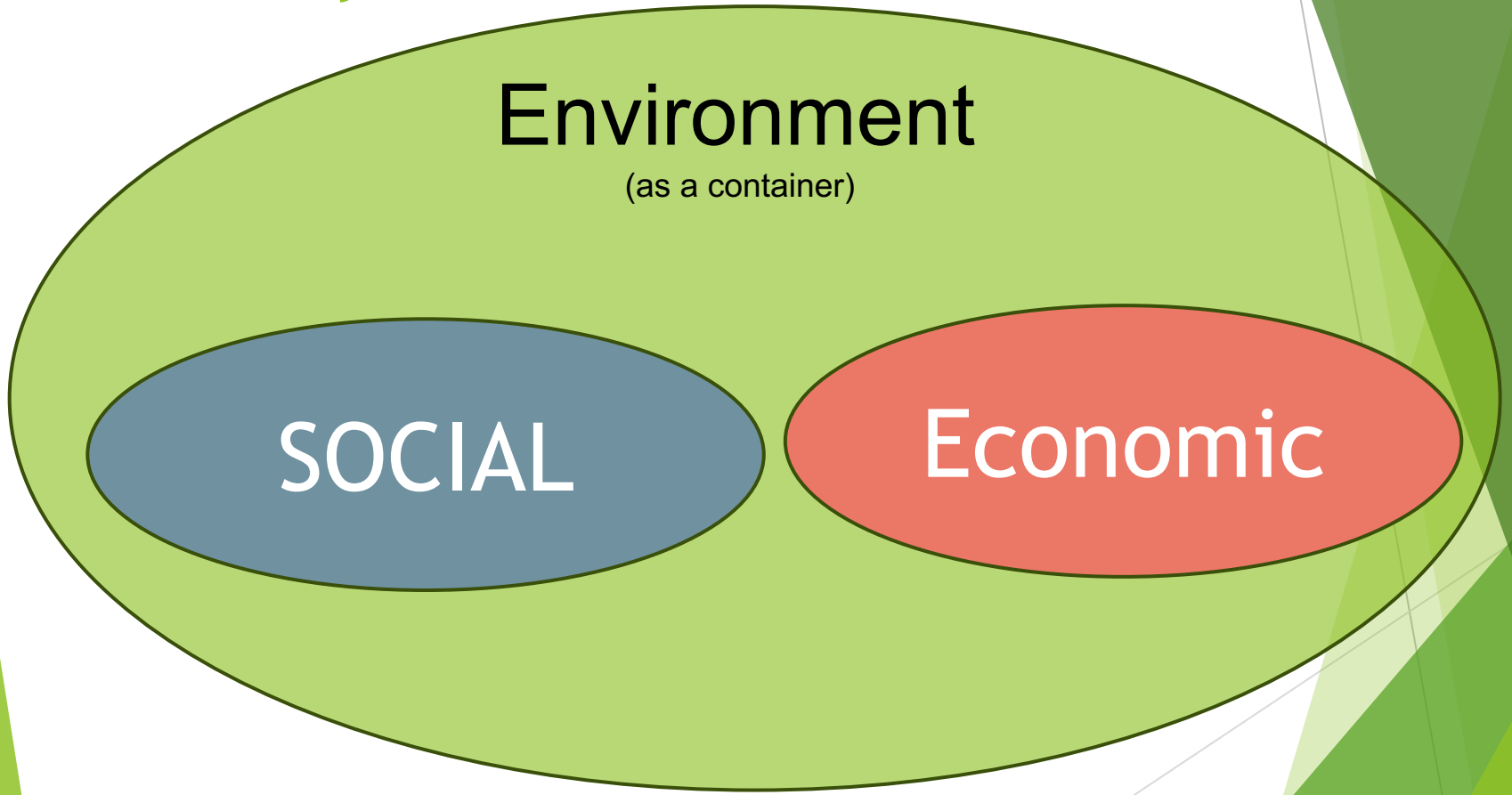
- To all the youth in Springfield, Waltham, Boston, Worcester, and Lafayette, Louisiana who are participating and have participated in the programs
- All the teachers who have helped and taught and that we have learned so much from
- The youth leaders and alumni
- Our public school partners and the BC team

Rental and Income Properties

- Rental Properties, head south much more rental properties and fewer trees and other environmental issues start to pop up

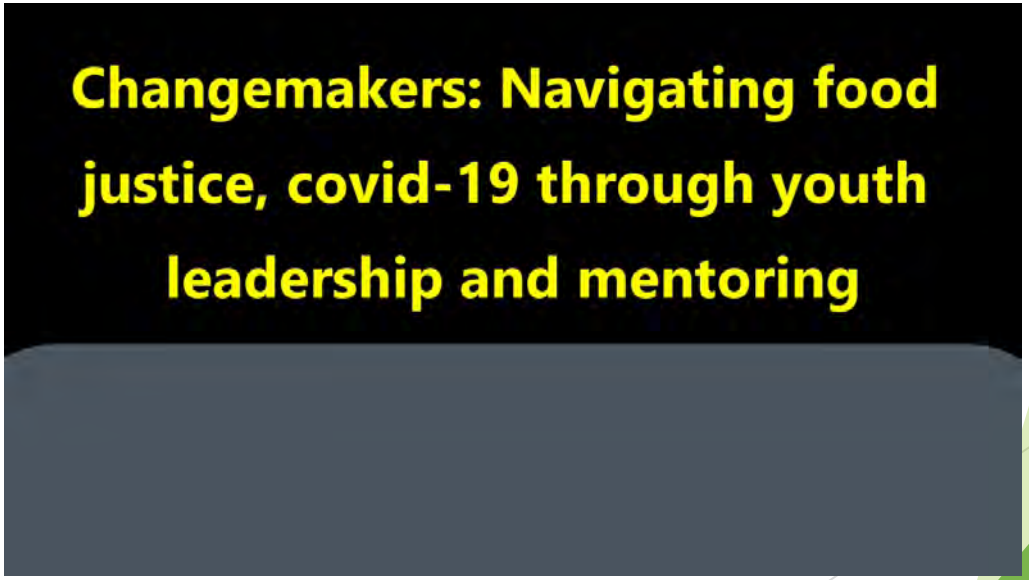


How many think of the environment…..

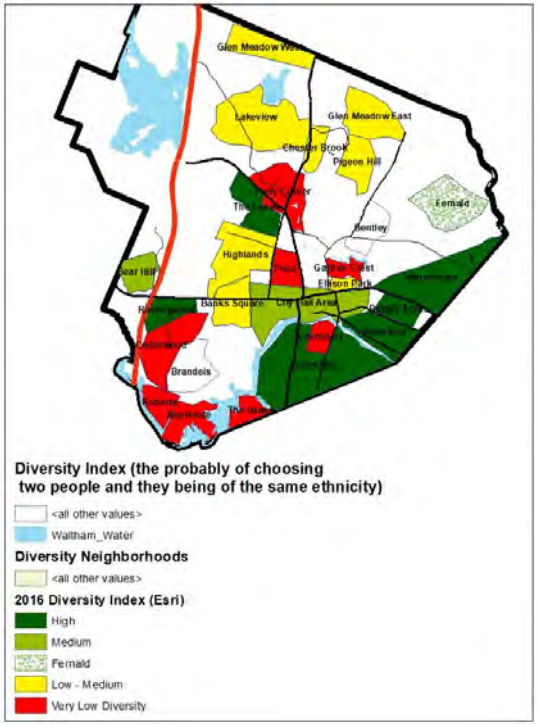


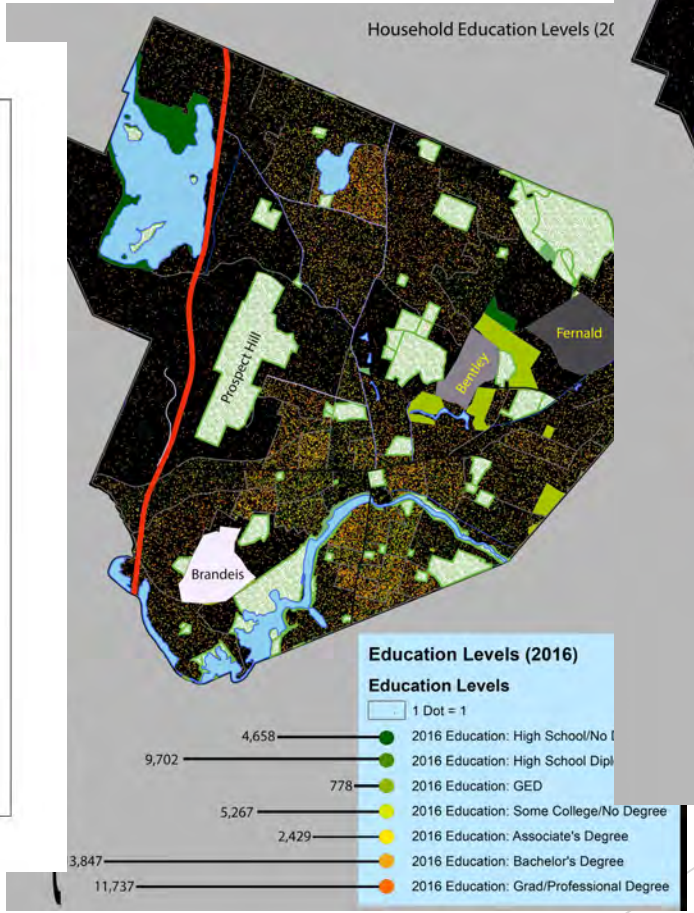
Why successful? Empowering Youth as role models

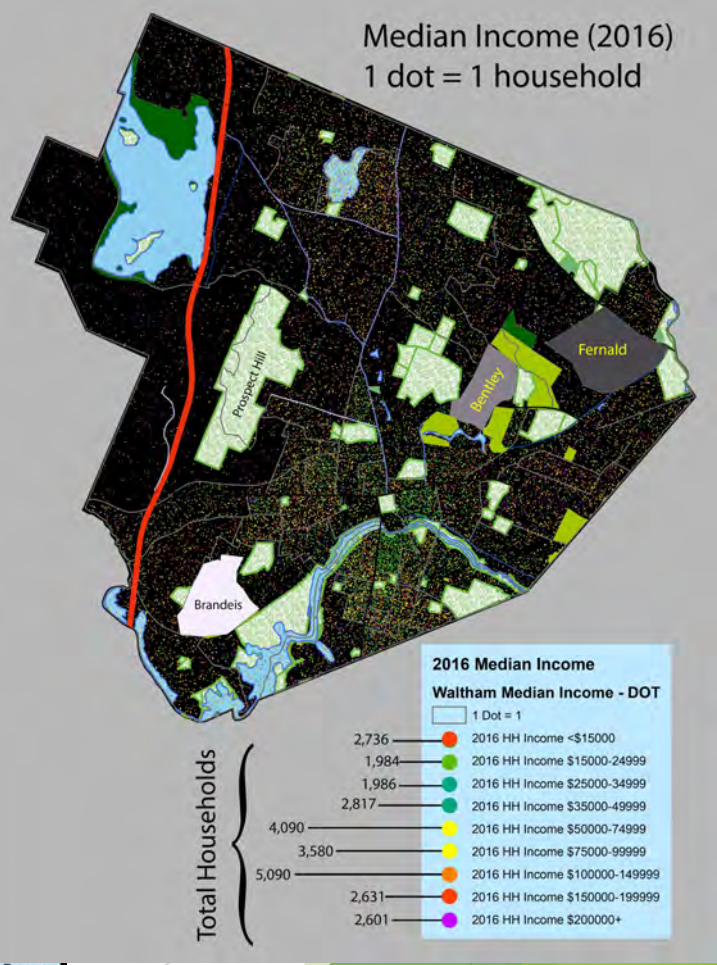
- ChangeMakers: Youth led mentoring around food justice



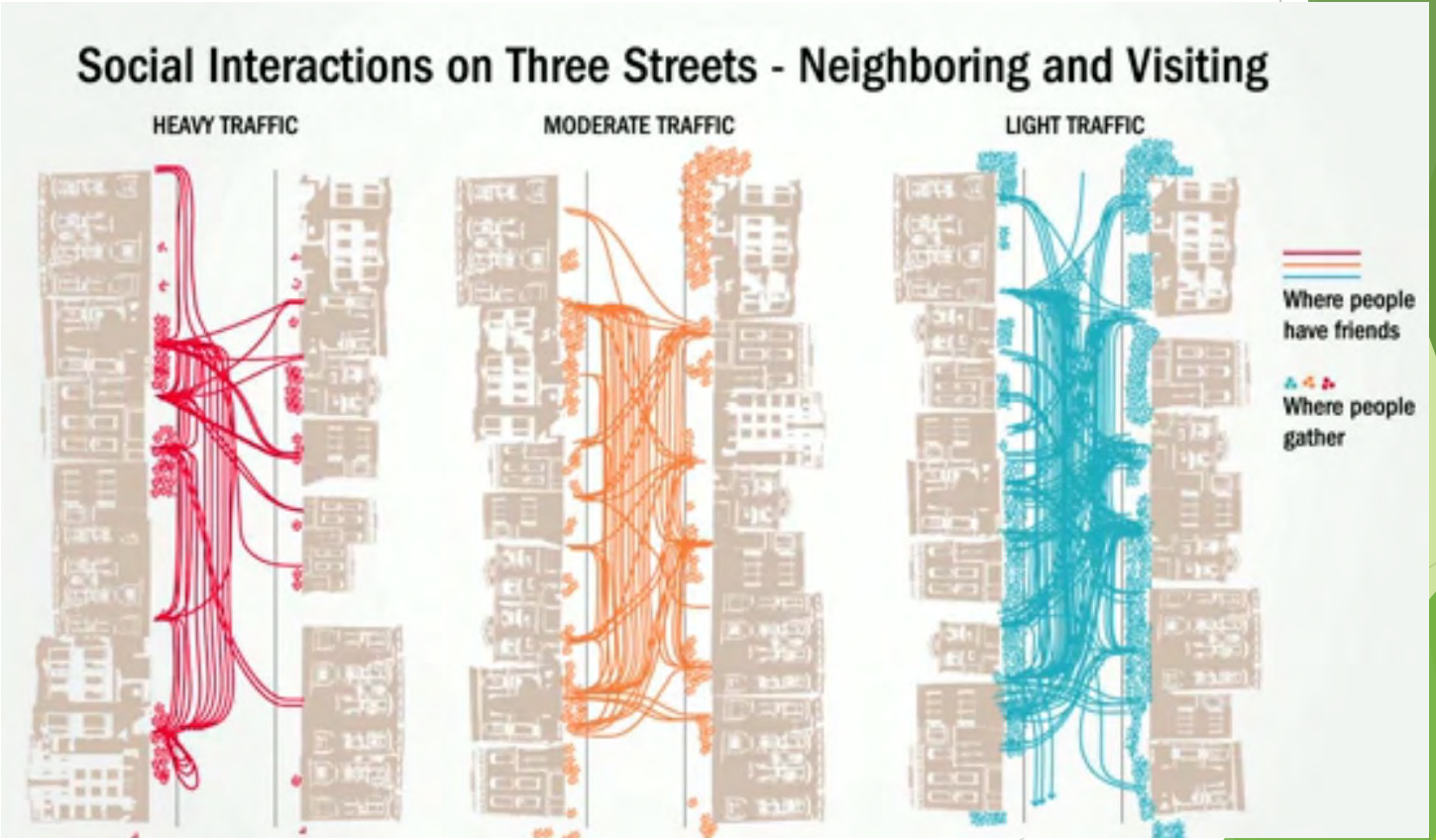
Made a ton maps….







Impact of cars



So a tree does what…

- The net carbon emission avoidance for a 7.6-m (25-ft) deciduous tree (red maples) was 27.7 kg C per year (61.1 lb C/yr). (Nowak, et al., 2002)
  - Reduction of energy use
  - Provide shade to a building
    - Improve efficiency of air conditioning units in the summer
    - Windbreaks in the winter

Create a Community learning ecosystem to foster STEM identity development

- Friends, Family, and Adults perception can drive youth toward or away from STEM
- Youth need to have opportunities for interest, self-efficacy, and expectations to flourish
- If the significant adult do not see a young person as someone capable of doing STEM
  - Far less likely to pursue STEM (even if they start interested and motivated)

STEM Identity Discrepancy (Stets, et al., 2018)