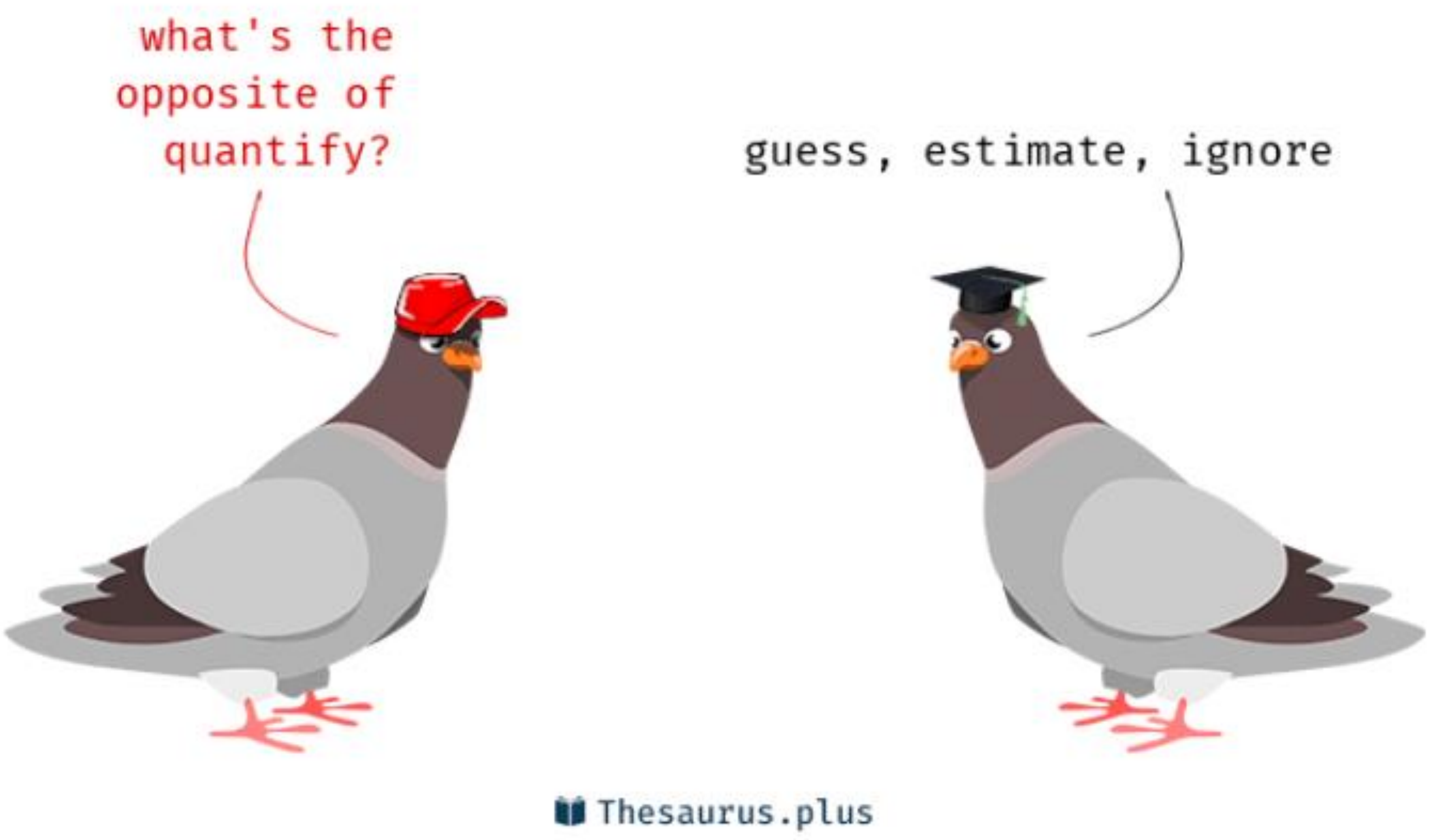
CITY OF CARMEL-BY-THE-SEA

The Urban Forest
&
a Changing Climate

Climate Committee

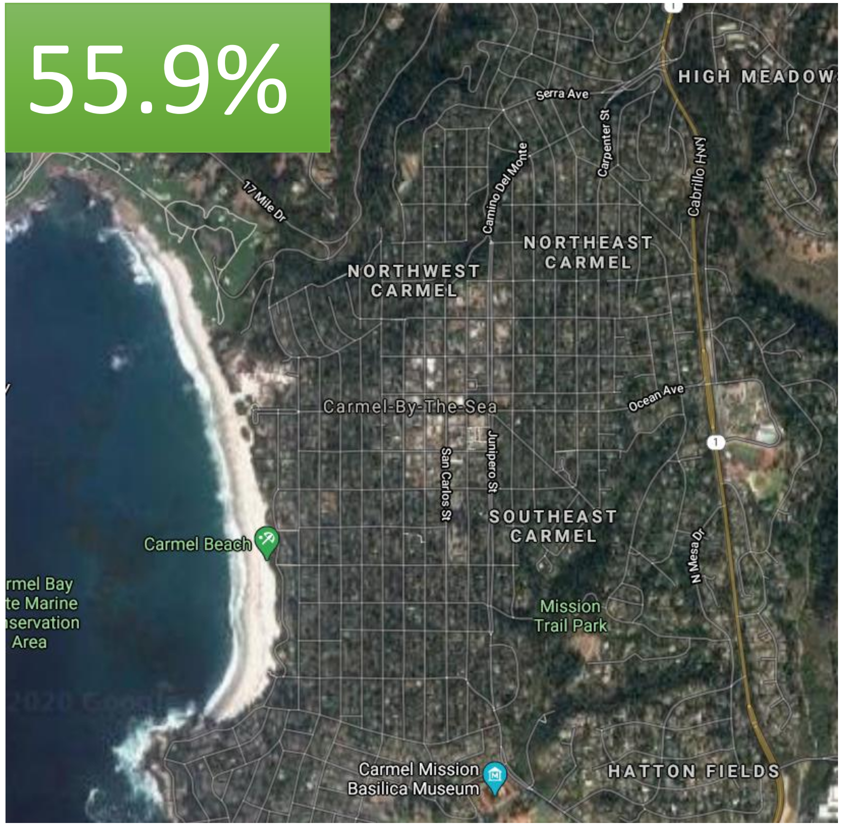
October 15, 2020

Starting point



Urban Tree Canopy

Urban Tree Canopy (UTC) refers to the layer of tree leaves, branches, and stems that provide tree coverage of the ground when viewed from above.



Urban Tree canopy

- LiDAR, aerial photography, and color infrared
- Costly
- Partner with the USFS or research institution

Three different ways to measure tree canopy from left to right: LiDAR, aerial photography, and color infrared, with Seattle's final LiDAR-based tree canopy result mapped on the far right. Source: City of Seattle.

Urban Tree Canopy

i-Tree

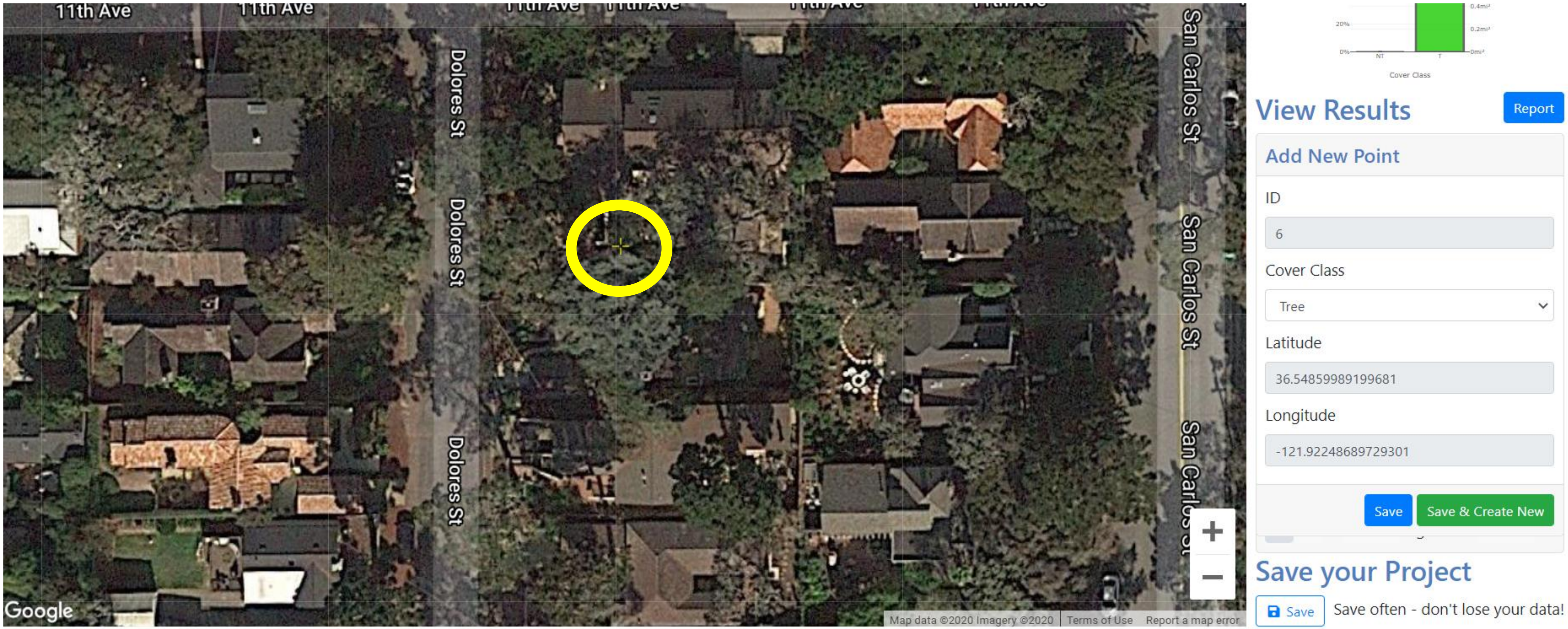
Tools for Assessing and Managing
Forests & Community Trees

- Free!
- Based on 20 years of research
- Modelling

Urban Tree Canopy

Use of this tool indicates acceptance of the EULA.

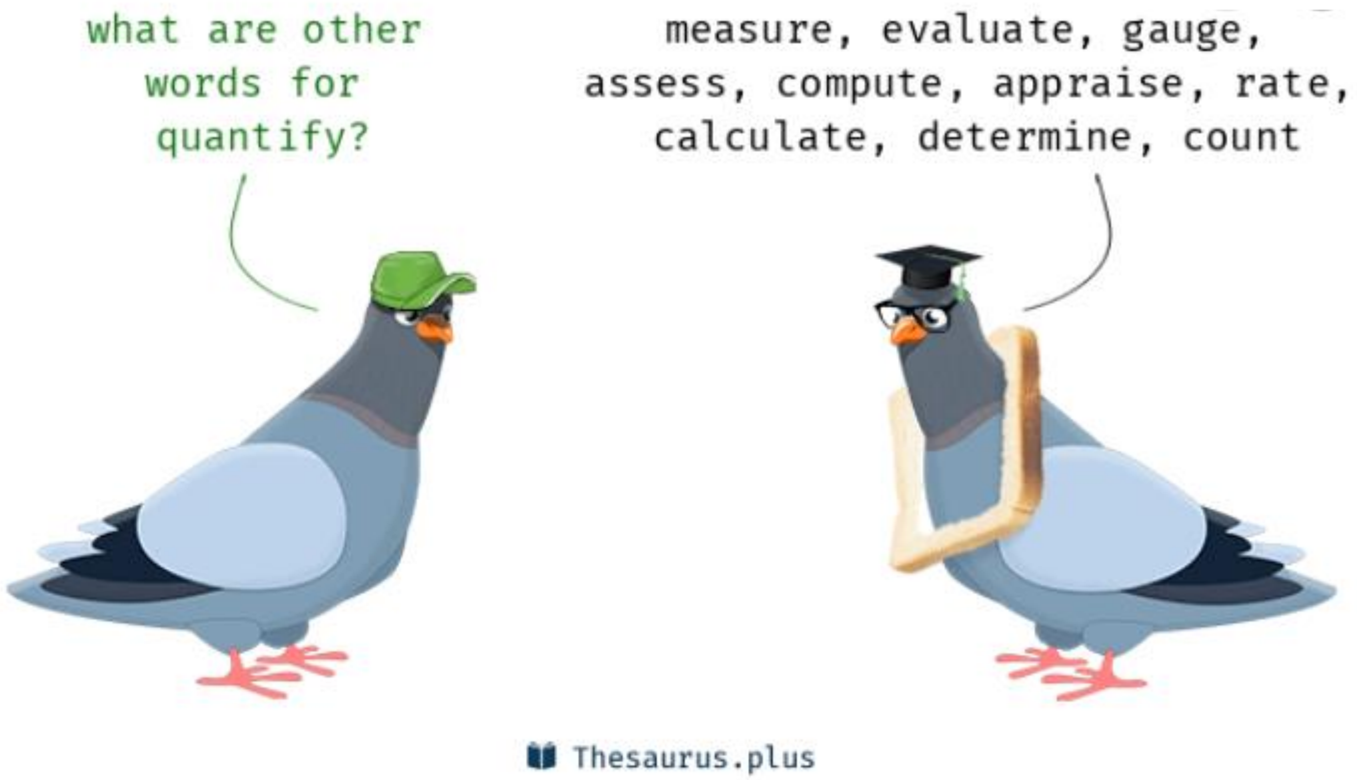
Urban Tree Canopy



Use of this tool indicates acceptance of the EULA.

Environmental Services

- 1399 points viewed
- Non-tree 44.03% ± 1.33
- Tree 55.97 % ± 1.33



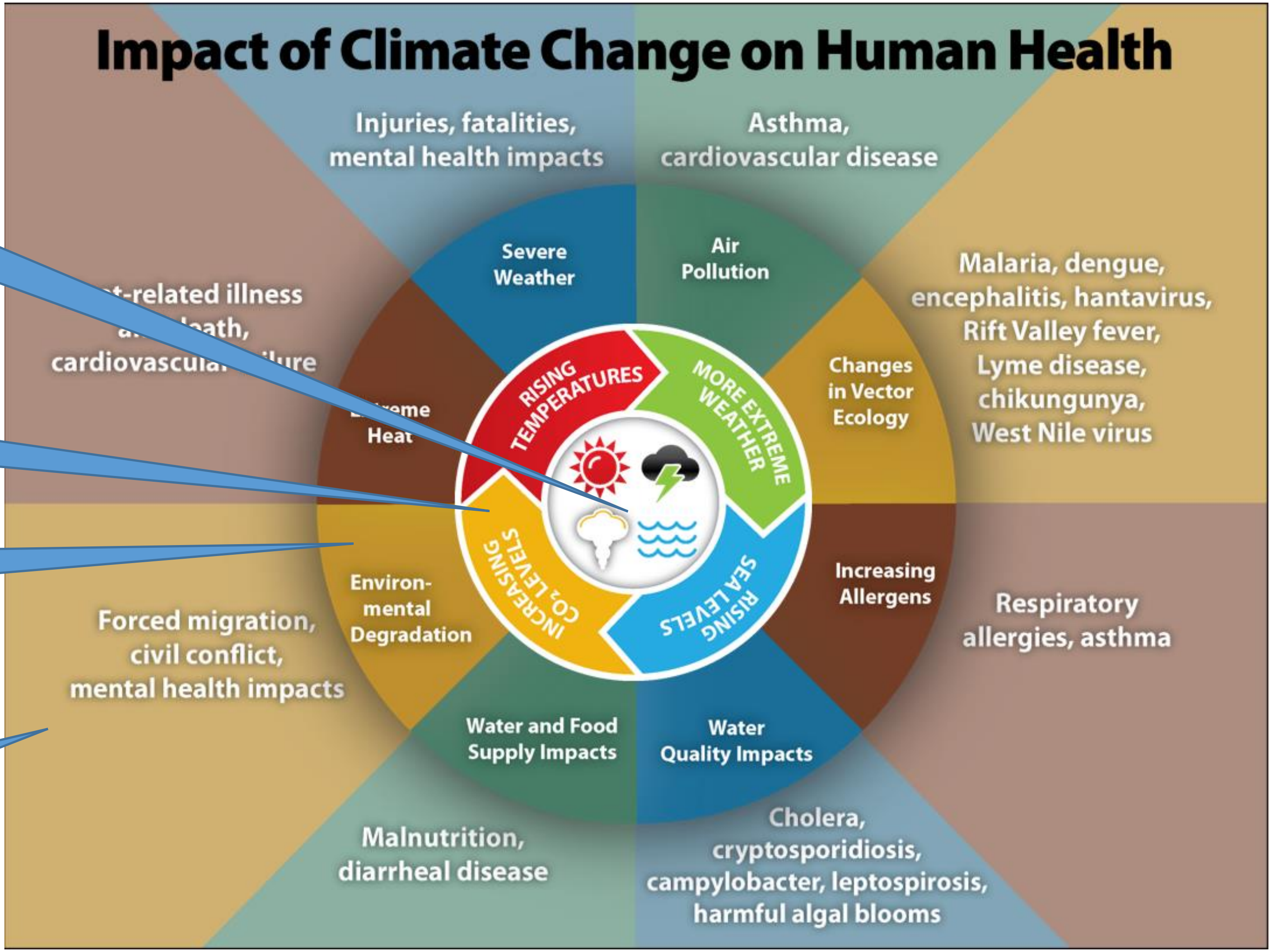
Climate Action and Adaptation

Climate Actions

Ramifications

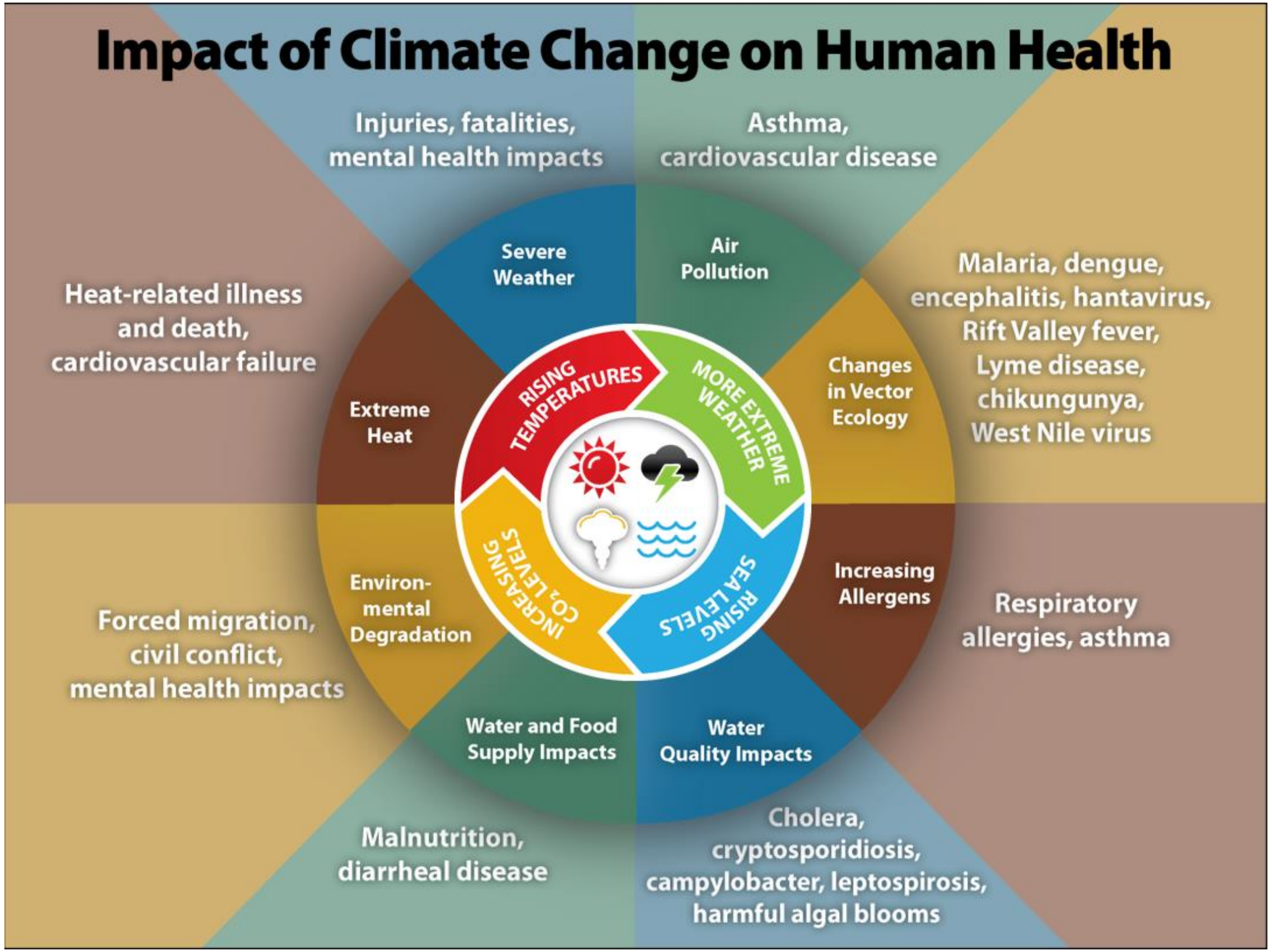
Climate Adaptation

Consequences

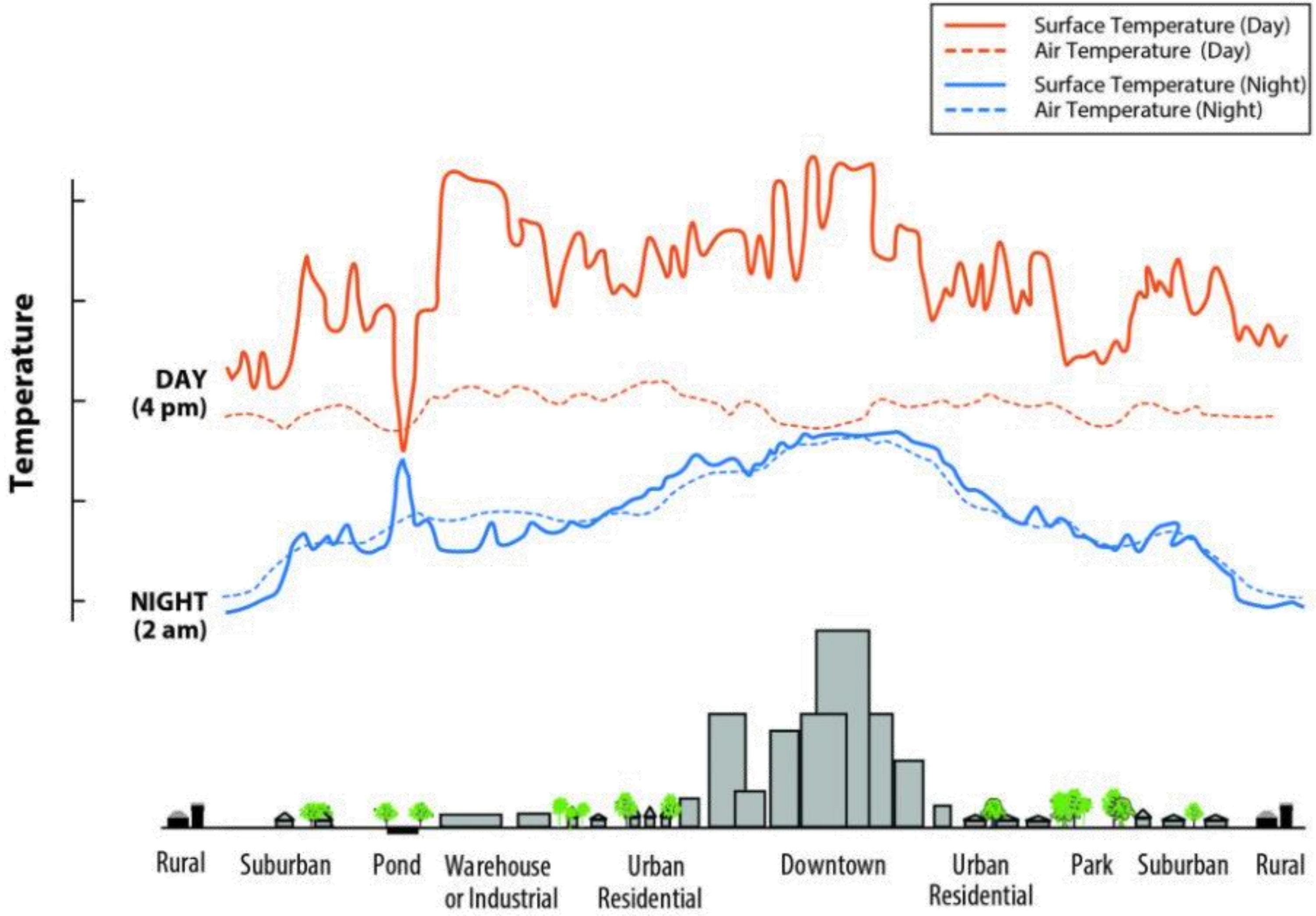


Vulnerabilities associated with the Urban Forest

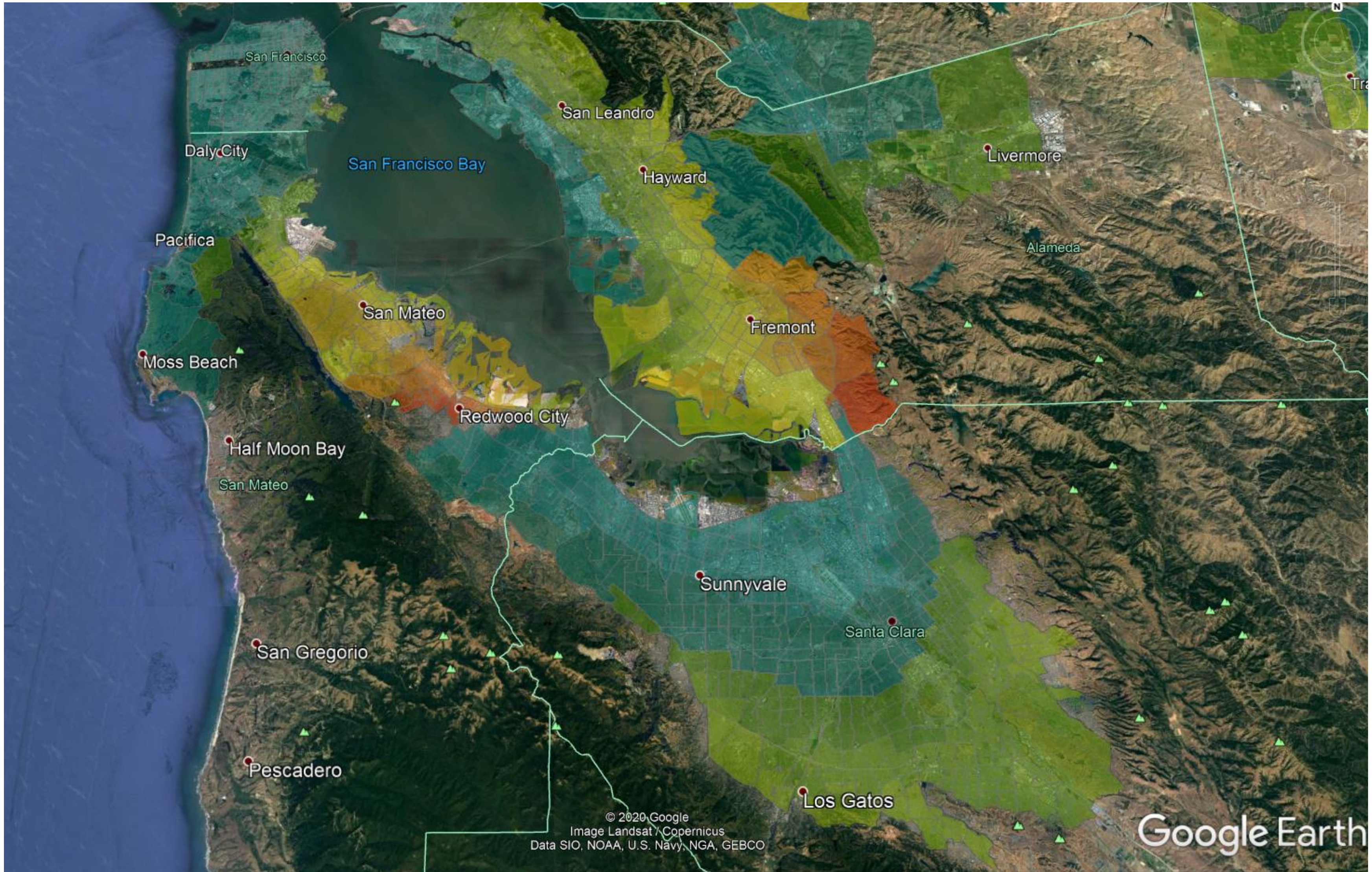
- Urban heat
- Stormwater runoff
- Air quality
- Storm damage
- Energy demands
- Water shortages
- Social resiliency
- Public Safety



Heat Island Effect

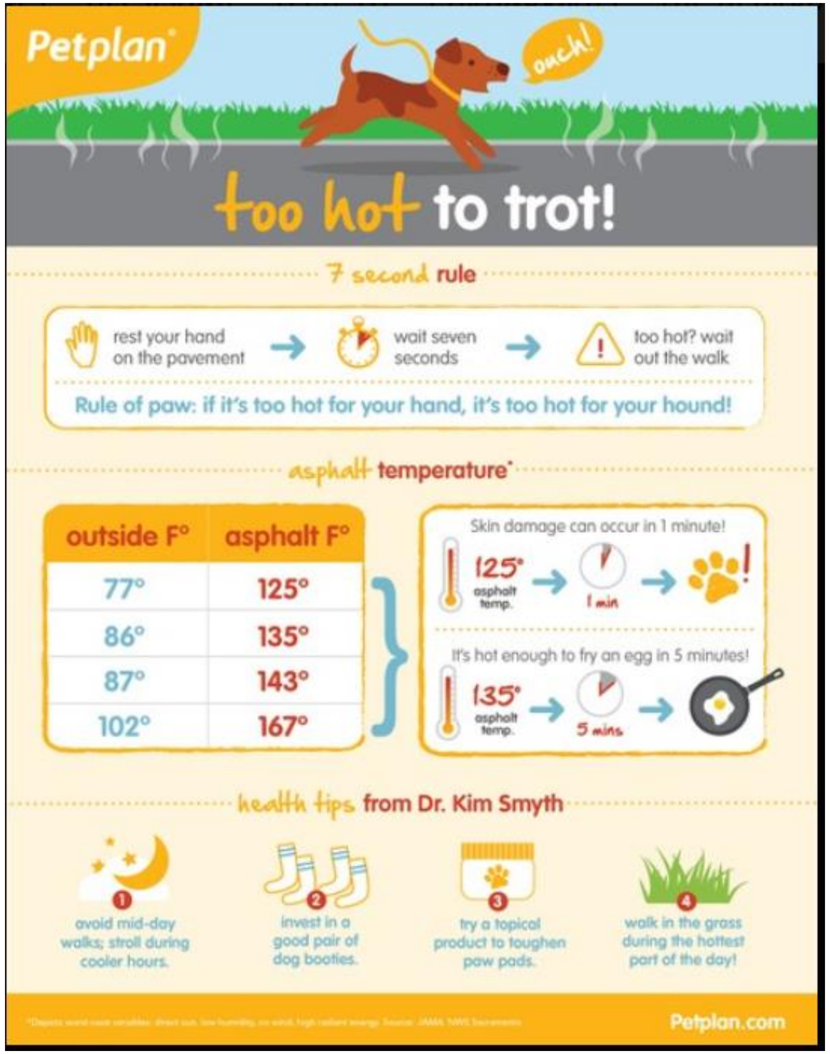


Urban Heat Island Effect



Increased Heat

- Increased transpiration rates
- Greater demand on irrigation
- Tree stress
- Increased evaporative emissions
- Increase energy consumption
- Less human activity
- Decreased human resiliency



Good News


Data CSUMB SFML, CA OPC
Data MBARI
Google Earth
36°40'51.56" N 122°01'14.29" W elev -1450 ft eye alt 16.59 mi

Stormwater Runoff

- 5,950,000 gallons of rainfall can be managed in the canopy
- Slows down peak flow
- Adds to soil moisture

Tree Benefit Estimates: Hydrological (English units)

Abbr.	Benefit	Amount (Mgal)	±SE	Value (USD)	±SE
AVRO	Avoided Runoff	5.95	±0.14	$53,207	±1,262
E	Evaporation	27.05	±0.64	N/A	N/A
I	Interception	27.09	±0.64	N/A	N/A
T	Transpiration	39.99	±0.95	N/A	N/A
PE	Potential Evaporation	173.65	±4.12	N/A	N/A
PET	Potential Evapotranspiration	138.43	±3.28	N/A	N/A

Currency is in USD. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Hydrological Estimates are based on these values in Mgal/ac/yr @ $/Mgal/yr:
AVRO 0.016 @ $8,936.00 | E 0.073 @ N/A | I 0.074 @ N/A | T 0.109 @ N/A | PE 0.471 @ N/A | PET 0.376 @ N/A (English units: Mgal = millions of gallons, ac = acres)

Action

Air Quality

Tree Benefit Estimates: Air Pollution (English units)

Abbr.	Description	Amount (lb)	±SE	Value (USD)	±SE
CO	Carbon Monoxide removed annually	602.79	±14.29	$402	±10
NO2	Nitrogen Dioxide removed annually	1,779.69	±42.20	$725	±17
O3	Ozone removed annually	18,052.60	±428.10	$49,307	±1,169
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	6,264.99	±148.57	$19,636	±466
PM2.5	Particulate Matter less than 2.5 microns removed annually	459.90	±10.91	$46,887	±1,112
SO2	Sulfur Dioxide removed annually	529.73	±12.56	$100	±2
Total		**27,689.70**	**±656.63**	**$117,057**	**±2,776**

Currency is in USD. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Air Pollution Estimates are based on these values in lb/ac/yr @ $/lb/yr:
CO 1.636 @ $0.67 | NO2 4.830 @ $0.41 | O3 48.990 @ $2.73 | PM10* 17.002 @ $3.13 | PM2.5 1.248 @ $101.95 | SO2 1.438 @ $0.19 (English units: lb = pounds, ac = acres)

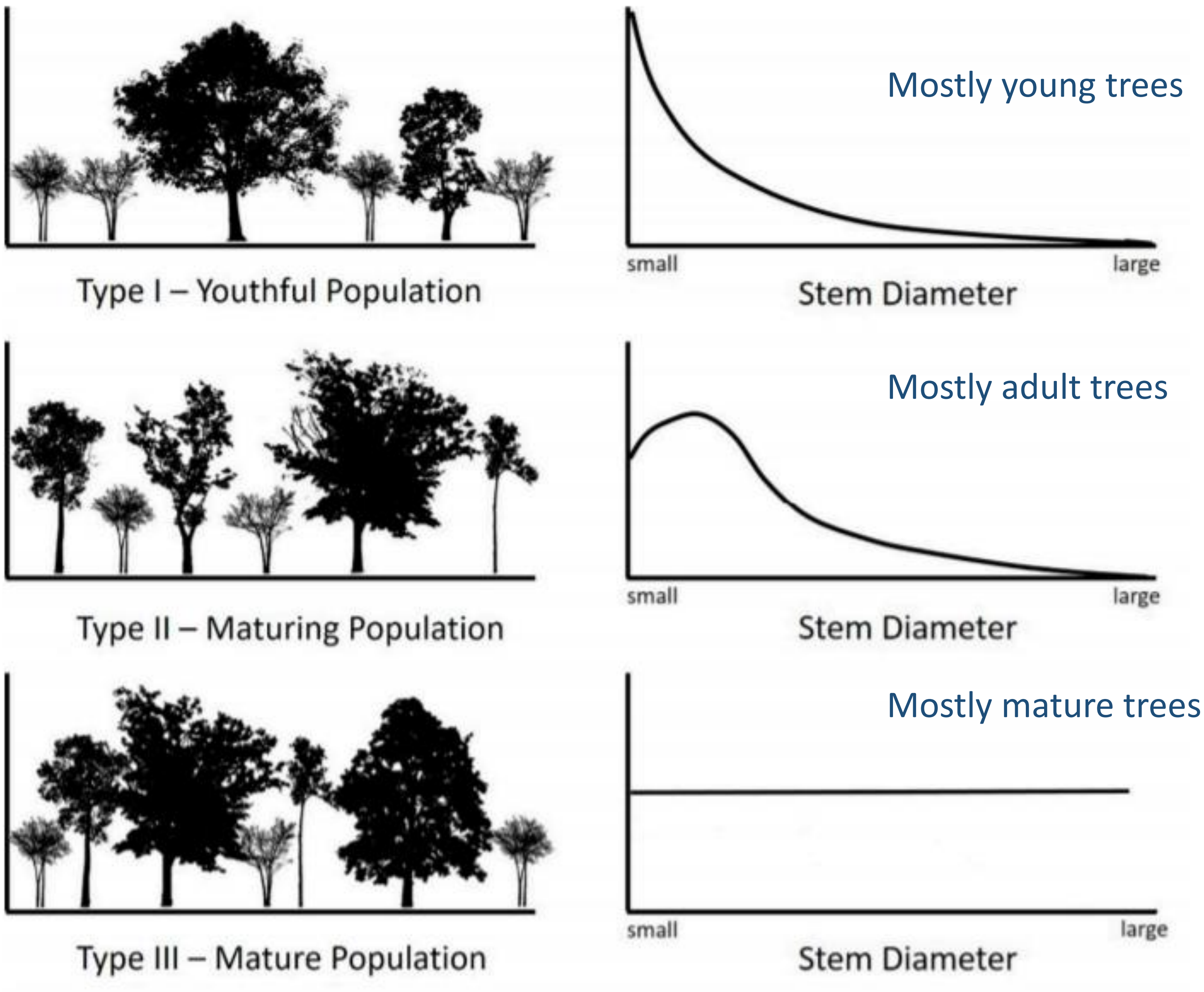
Tree population

- 12,632 tons of carbon currently stored (older trees)
- 503 tons of carbon can be sequestered annually (younger trees)

Tree Benefit Estimates: Carbon (English units)

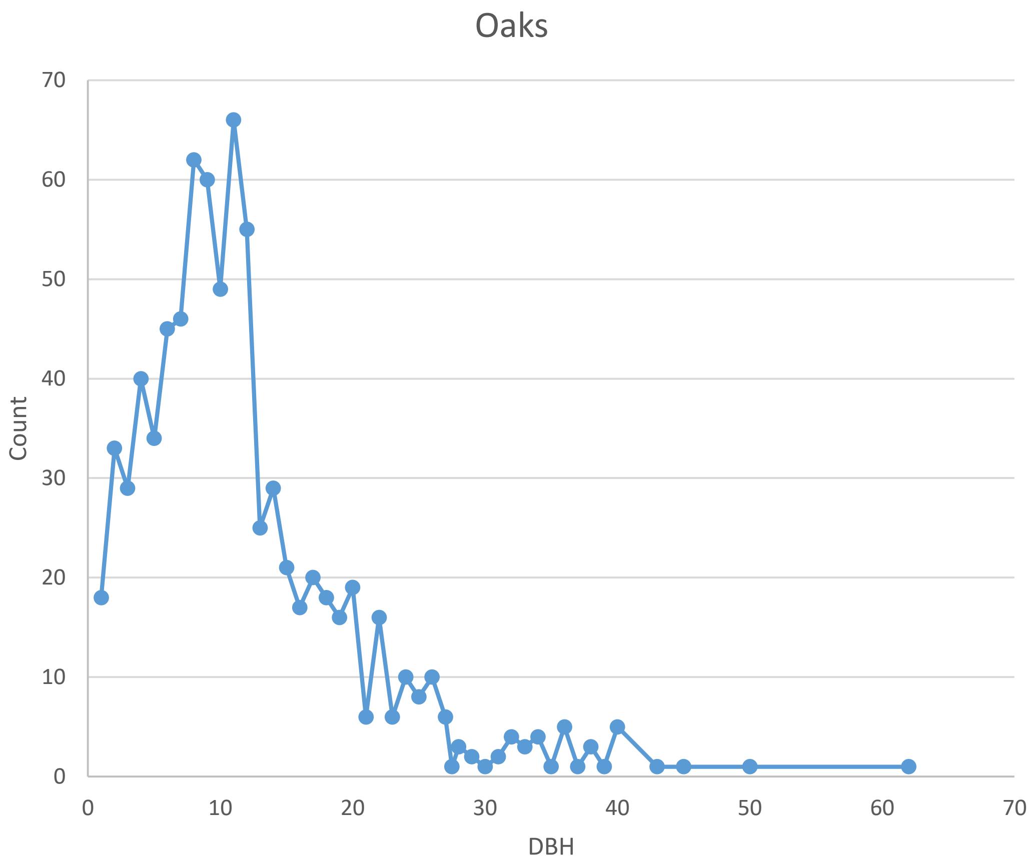
Description	Carbon (T)	±SE	CO_2 Equiv. (T)	±SE	Value (USD)	±SE
Squestered annually in trees	503.01	±11.93	1,844.35	±43.74	$85,783	±2,034
Stored in trees (Note: this benefit is not an annual rate)	12,632.36	±299.56	46,318.67	±1,098.39	$2,154,344	±51,088

Currency is in USD. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Carbon sequestered is based on 1.365 T/ac/yr. Carbon stored is based on 34.281 T/ac. Carbon is valued at $46.51/T. (English units: T = tons (2,000 pounds), ac = acres)

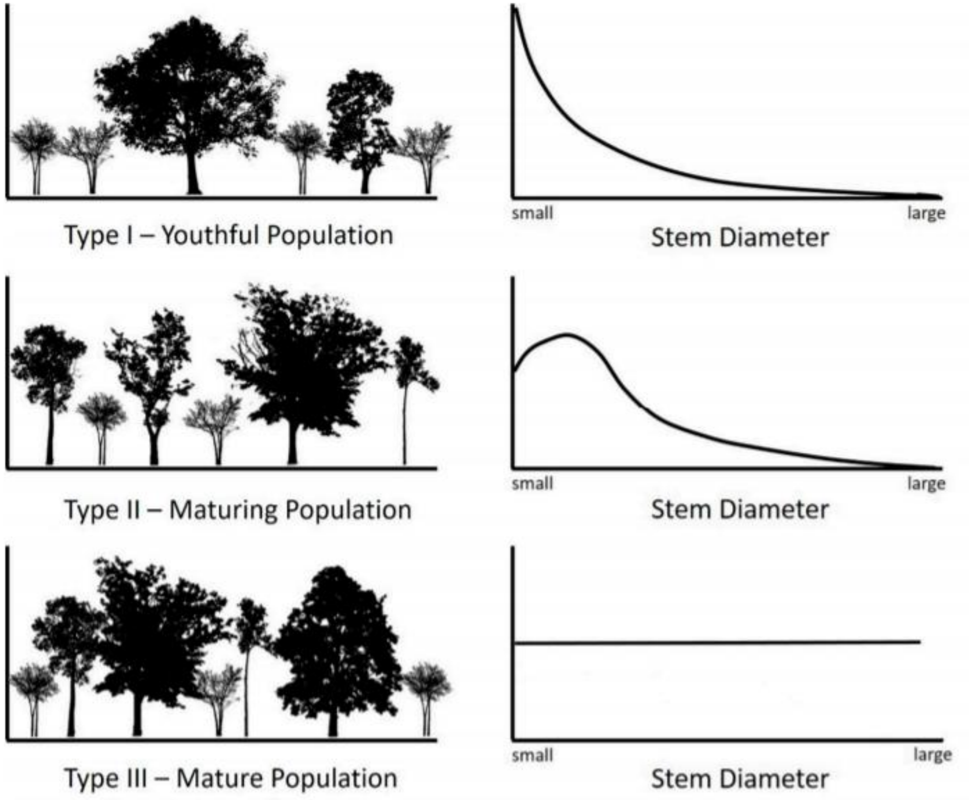


DBH Distributions in America's Urban Forests—An Overview of Structural Diversity Justin Morgenroth 1,*, David J. Nowak 2 and Andrew K. Koeser 3 Received: 28 November 2019; Accepted: 21 January 2020; Published: 23 January 2020

Oaks

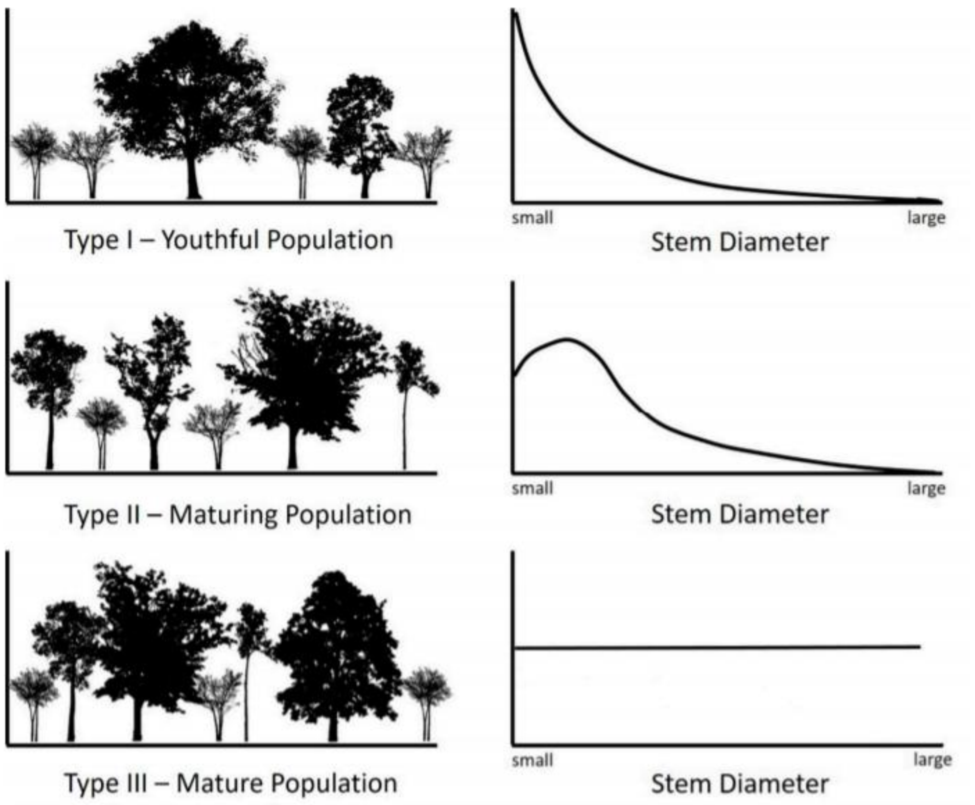


Oaks
70
60
50
40
30
20
10
0
Count
0
10
20
30
40
50
60
70
DBH



Type I – Youthful Population
small
large
Stem Diameter
Type II – Maturing Population
small
large
Stem Diameter
Type III – Mature Population
small
large
Stem Diameter

Pines



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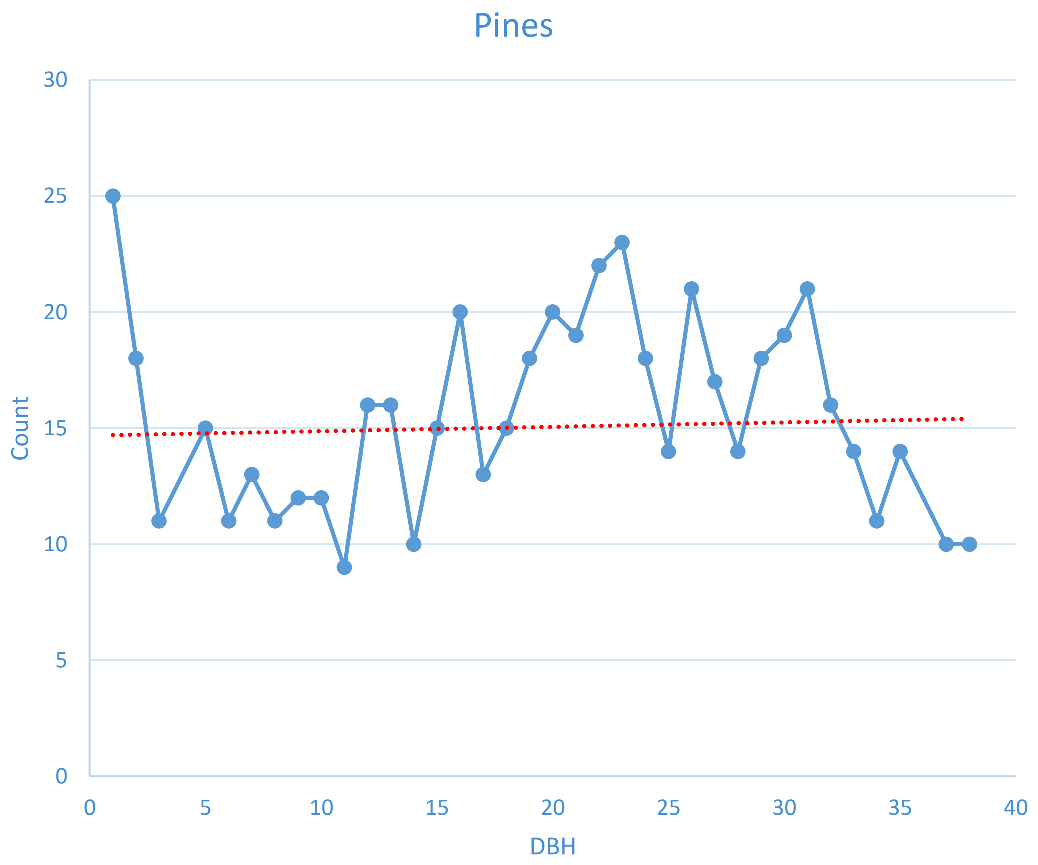


Pines
Count
DBH
0
5
10
15
20
25
30
35
40

Species Distribution

Municipal Tree Care & Management in the United States: A 2014 Urban & Community Forestry Census of Tree Activities

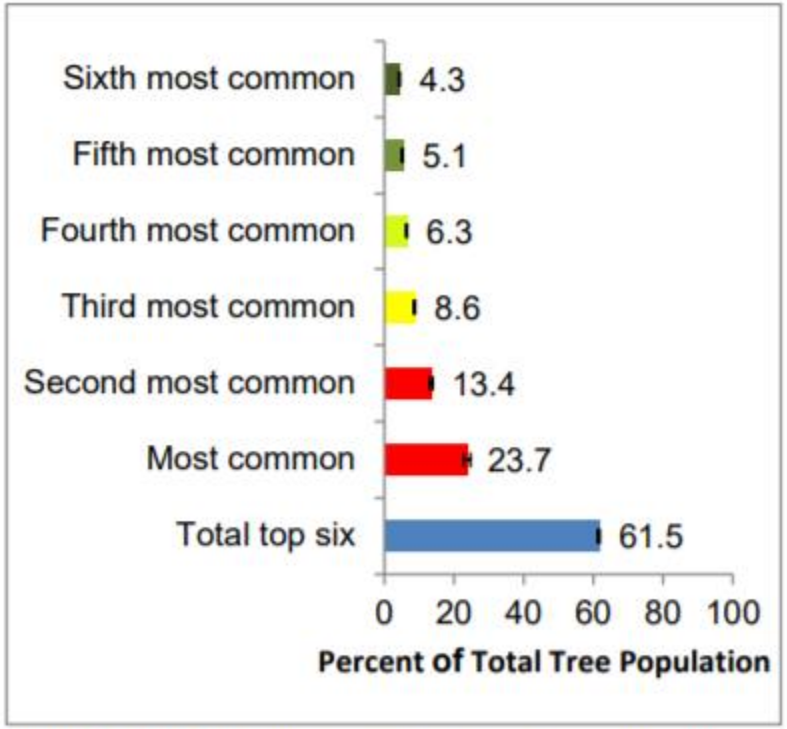
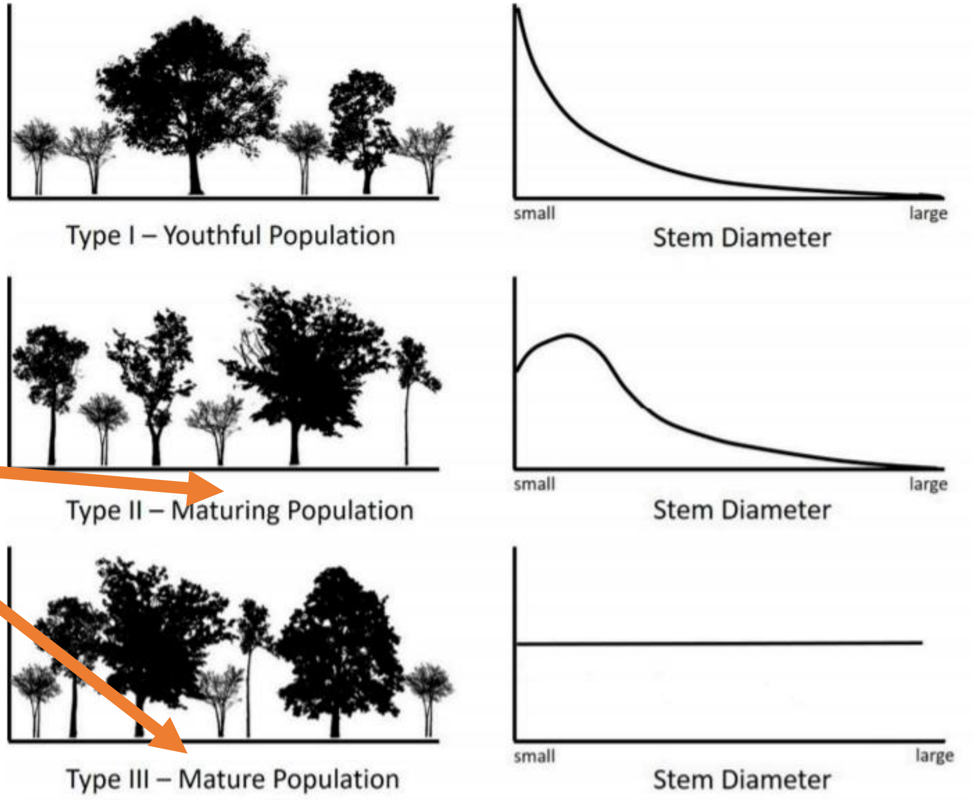


Figure 6-14. If known, list the 6 most commonly occurring street tree species, their number and percentage of the total street trees? (n=188)

Carmel top 6

6th	4%
5th	4%
4th	10
3rd	14%
2nd	27%
Most common	38%
Total top 6	77%



Water shortages

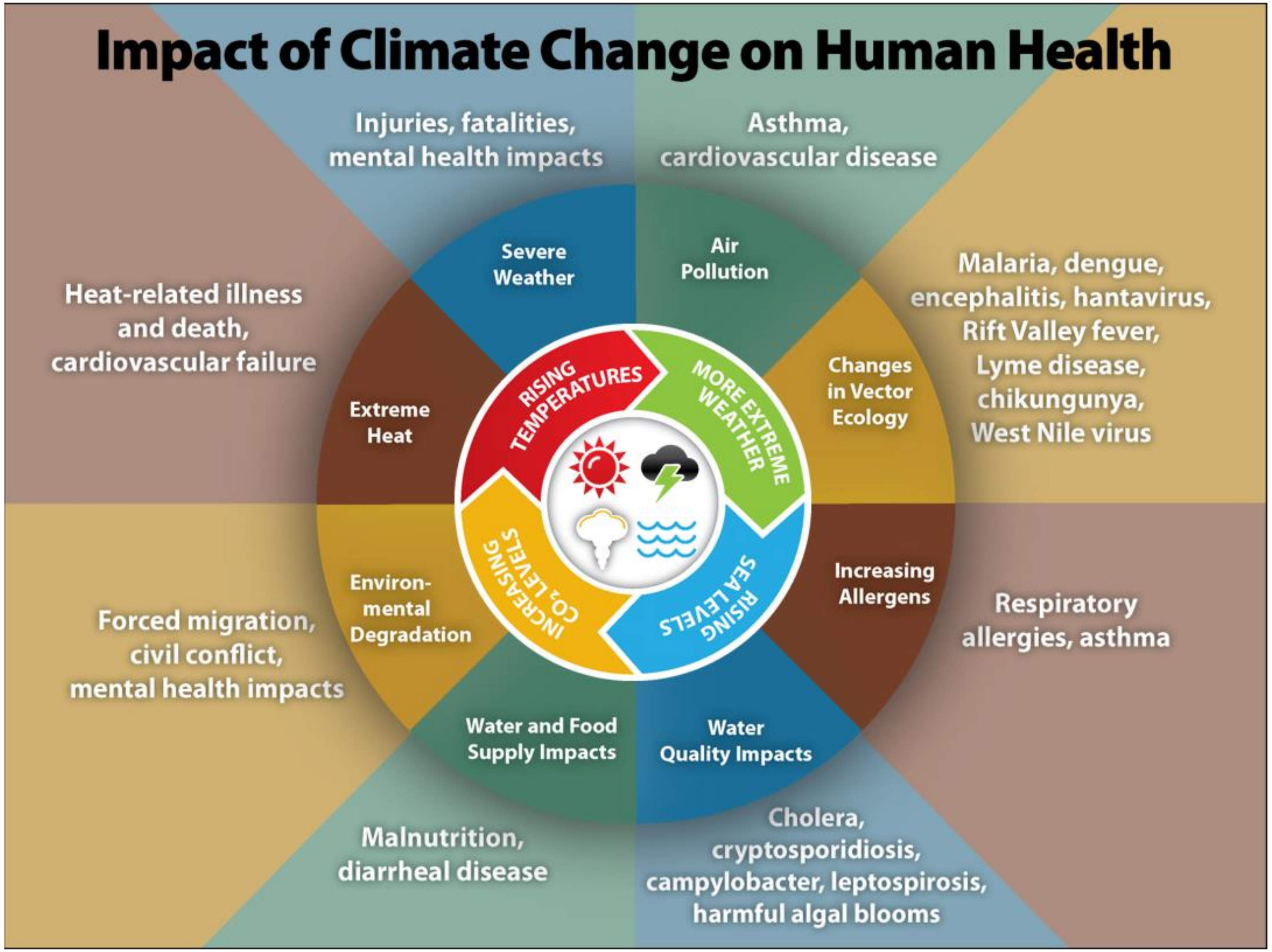
Loss of fog

- Irrigation adds demands on stressed water system
- Older trees become stressed and go into decline

Large storm events

Vulnerabilities associated with the Urban Forest

- ~~Urban heat~~
- ~~Stormwater runoff~~
- ~~Air quality~~
- Storm damage
- ~~Energy demands~~
- Water shortages
- ~~Social resiliency~~
- Public safety



Urban Forest Adaptation

Storm events

- Diversify the population
- Focus on preventative tree care for health and stability
- Remove trees in advanced decline

Loss of fog

- Diversify the population

Questions?

Possible new tree species

Image 3 of 15 - Pinus torreyana - tree-3 - M. Ritter, W. Mark and J. Reimer

Image 1 of 15 - Sequoiadendron giganteum - tree-2 - M. Ritter, W. Mark, A. Gillum and J. Reimer

Possible new tree species

Image 1 of 15 - Quercus suber - tree-4 - M. Ritter, W. Mark and J. Reimer

Image 4 of 15 - Cercis occidentalis - tree-2 - D. Lorenzo, J. Smith, M. Ritter, W. Mark and J. Reimer