

Mitigating Urban Heat Island Effect

Effective climate change adaptation strategies

Colter Sonneville, PLA, ISA Arborist dwg.



In San Antonio, the Poor Live on Their Own Islands of Heat

Texas has been hit with an unrelenting heat wave. Nowhere is it more miserable than in low-income areas that have less access to shade and air-conditioning.

Give this article



Heat waves kill people—and climate change is making it much, much worse

A recent study found that more than a third of all heat deaths worldwide can be pinned on climate change. Parts of the U.S. are feeling the danger now.

BY ALEJANDRA BORUNDA



PUBLISHED JULY 2, 2021 • 7 MIN READ

Why an East Harlem Street Is 31 Degrees Hotter Than Central Park West

If you want to map inequality in New York, you can just count trees.

Give this article



Environment ► **Climate crisis** Wildlife Energy Pollution Green light

US news


Deadly heat is killing Americans: A decade of inaction on climate puts lives at risk

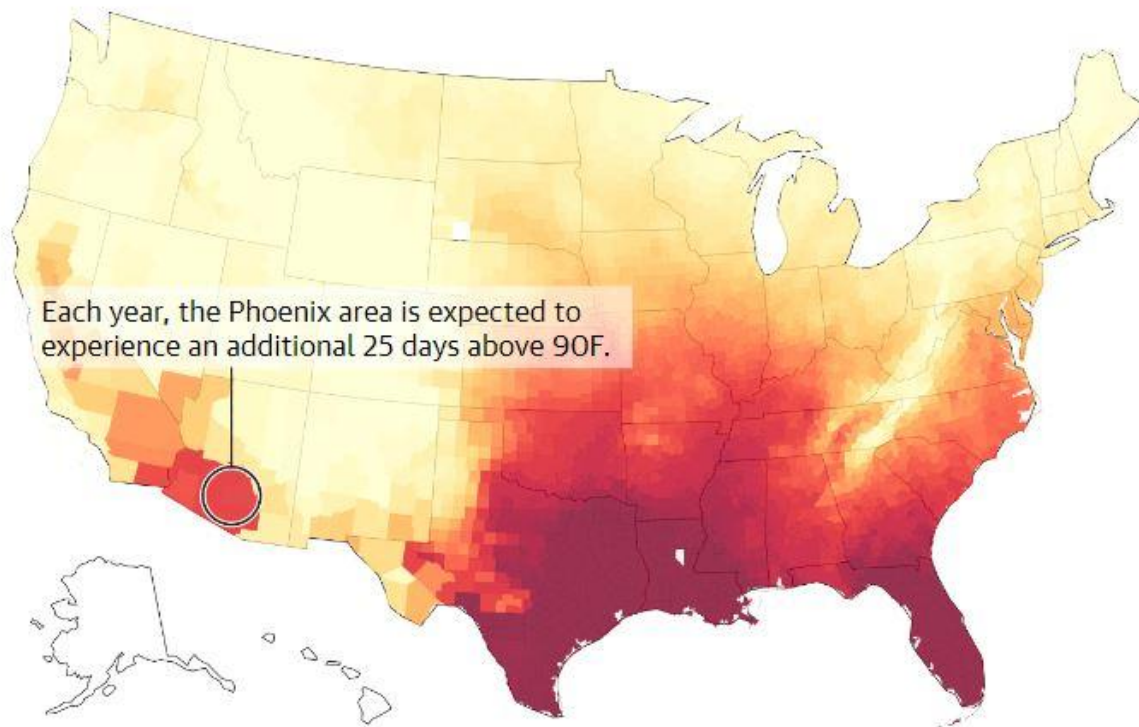
Dean Russell, Elisabeth Gawthrop, Veronica Penney, Ali Raj and Bridget Hickey, Columbia Journalism Investigations

Tue 16 Jun 2020 02:00 EDT



The US is expected to experience significantly more days above 90F by 2050

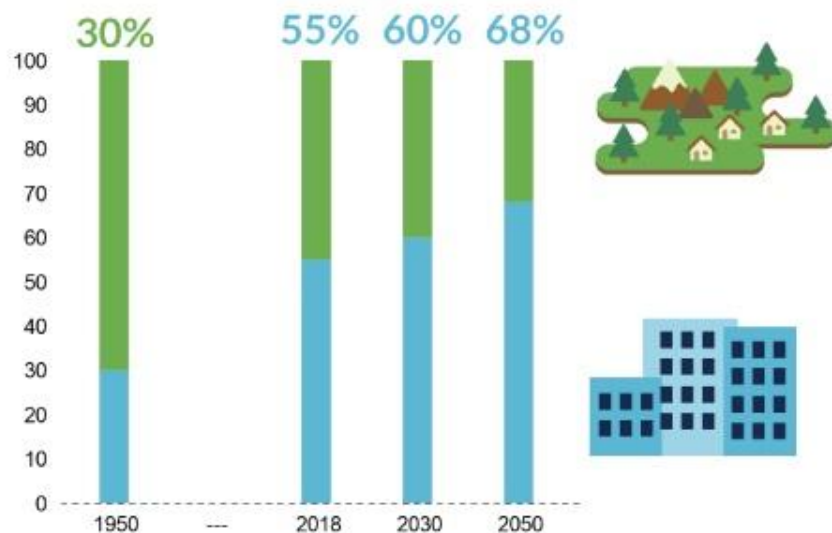
0  50 or more additional days above 90F



Guardian graphic. Source: Union of Concerned Scientists

Our future is urban!

From only **751 million** in 1950, the population of the world's cities has rocketed to **4.2 billion**.



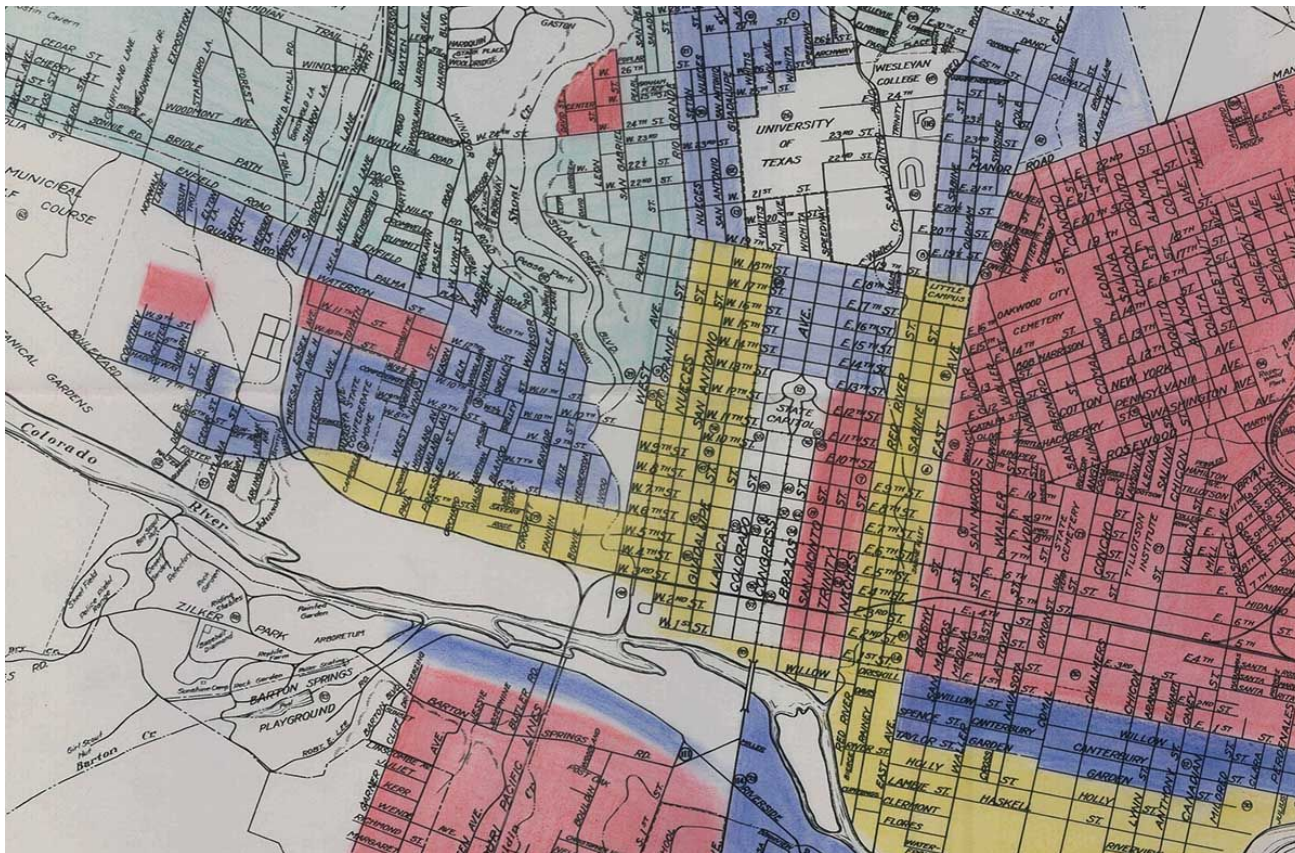
World Urbanization Prospects: The 2018 Revision

Access the report: bit.ly/wup2018 • #UNPopulation



UN DESA

UHI and communities of color



Article

B Urban Analytics and
City Science

Modeling the relationships between historical redlining, urban heat, and heat-related emergency department visits: An examination of 11 Texas cities

EPB: Urban Analytics and City Science

| 2022, Vol. 49(3) 933–952

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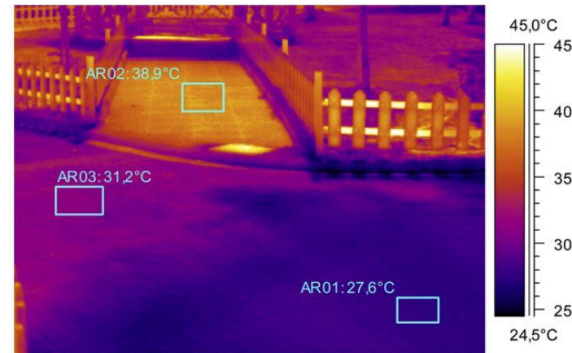


What is Urban Heat Island (UHI)?

“UHI refers to the observation of higher urban daytime and night temperatures in cities compared to surrounding suburban and rural areas”

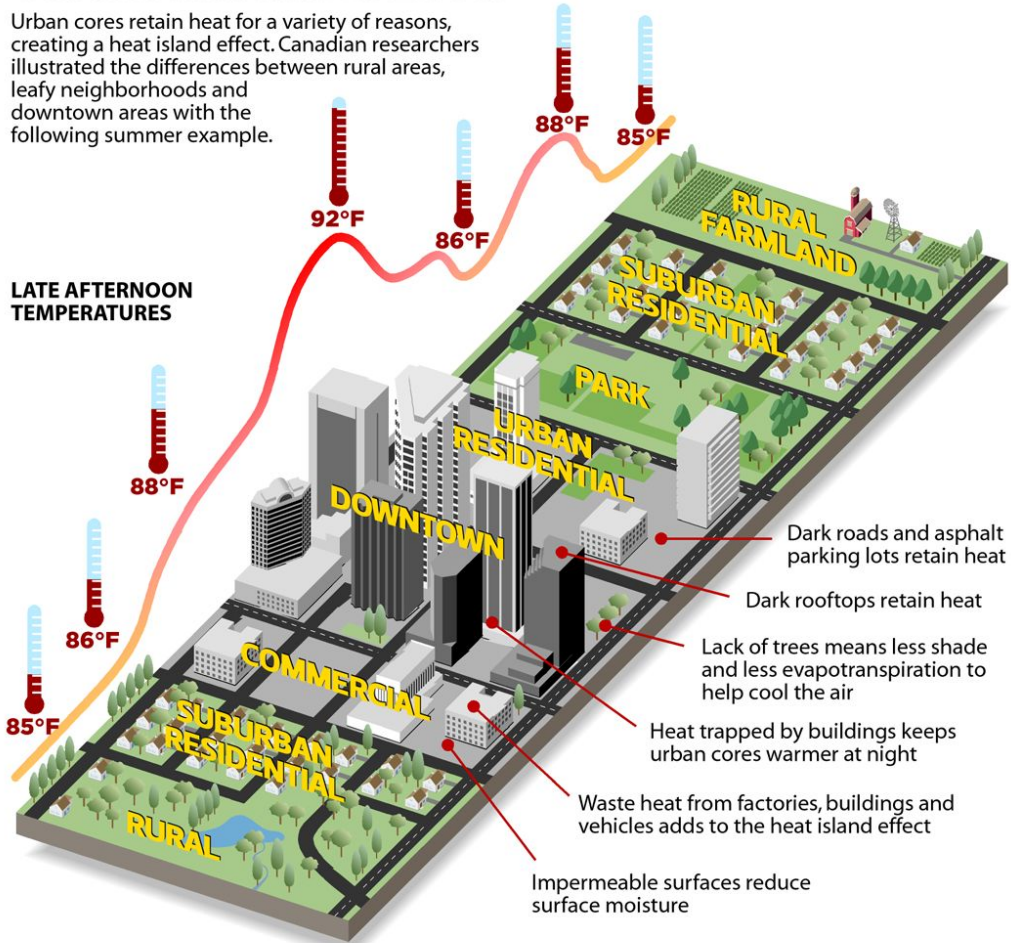
What's the cause?

- **Reduced tree canopy**
- **Slower wind speeds**
- **Anthropogenic heat sources (vehicles, AC units)**
- **Man-made materials (roof, asphalt) absorb & radiate energy**

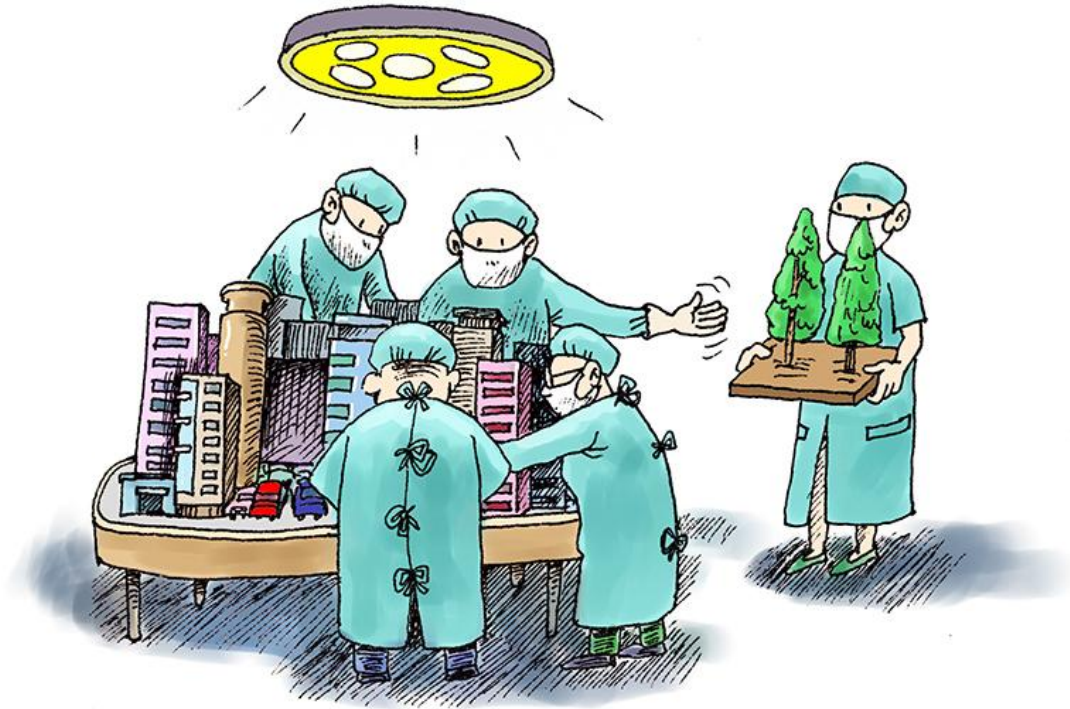


Urban Heat Island Effect

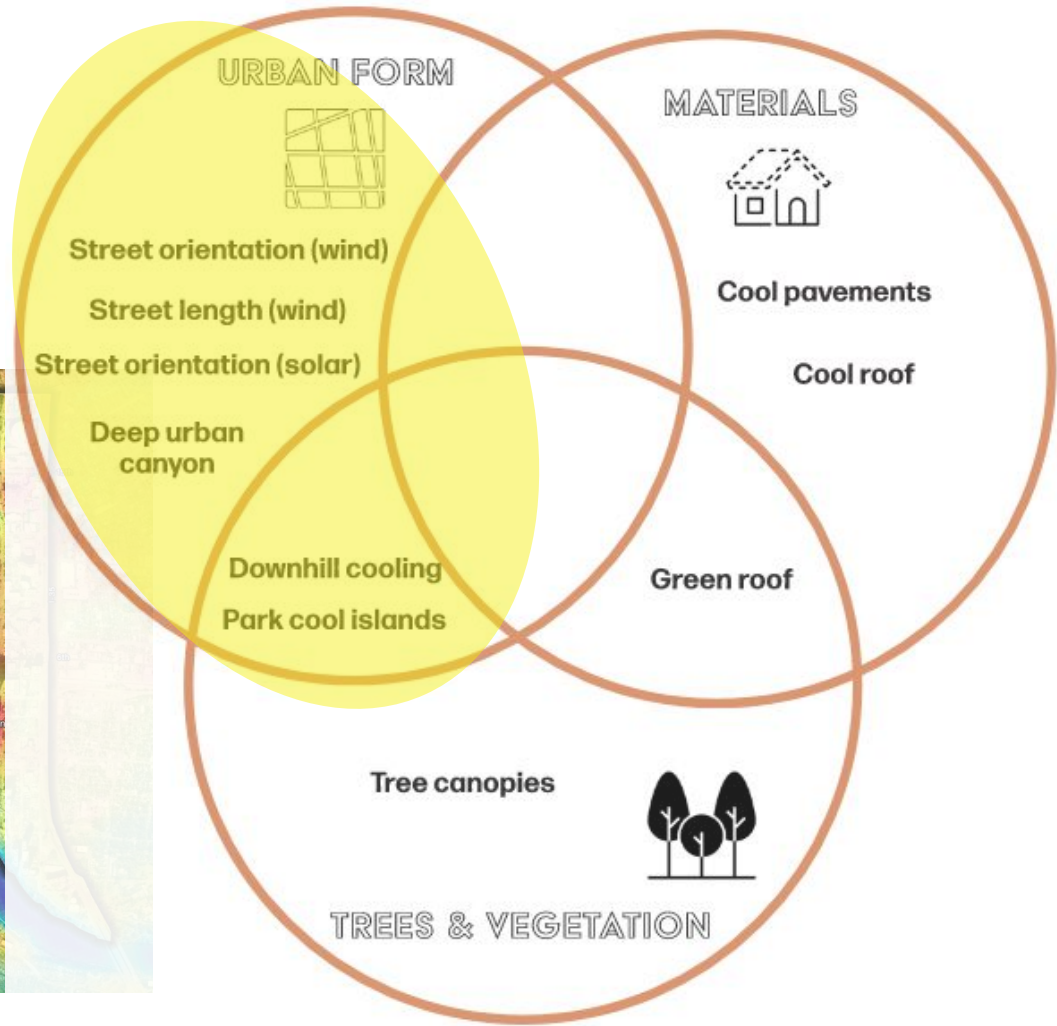
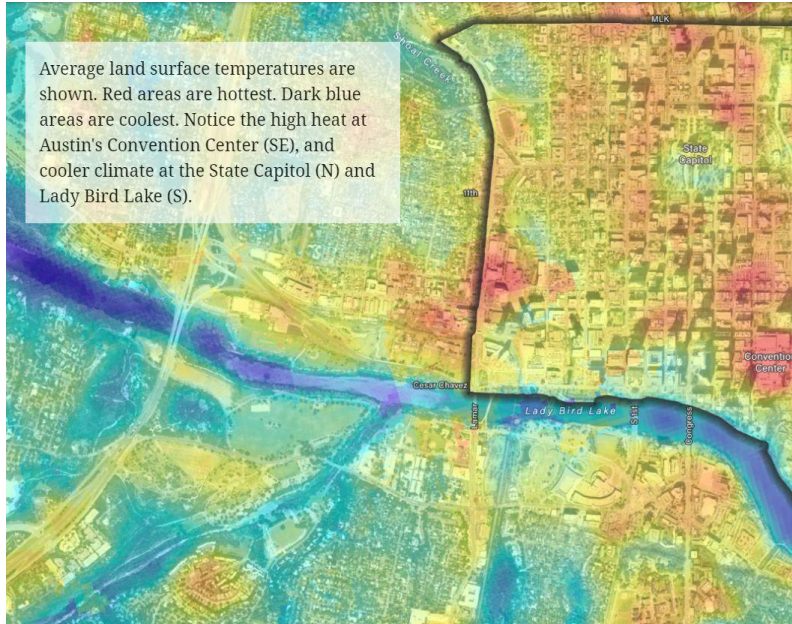
Urban cores retain heat for a variety of reasons, creating a heat island effect. Canadian researchers illustrated the differences between rural areas, leafy neighborhoods and downtown areas with the following summer example.



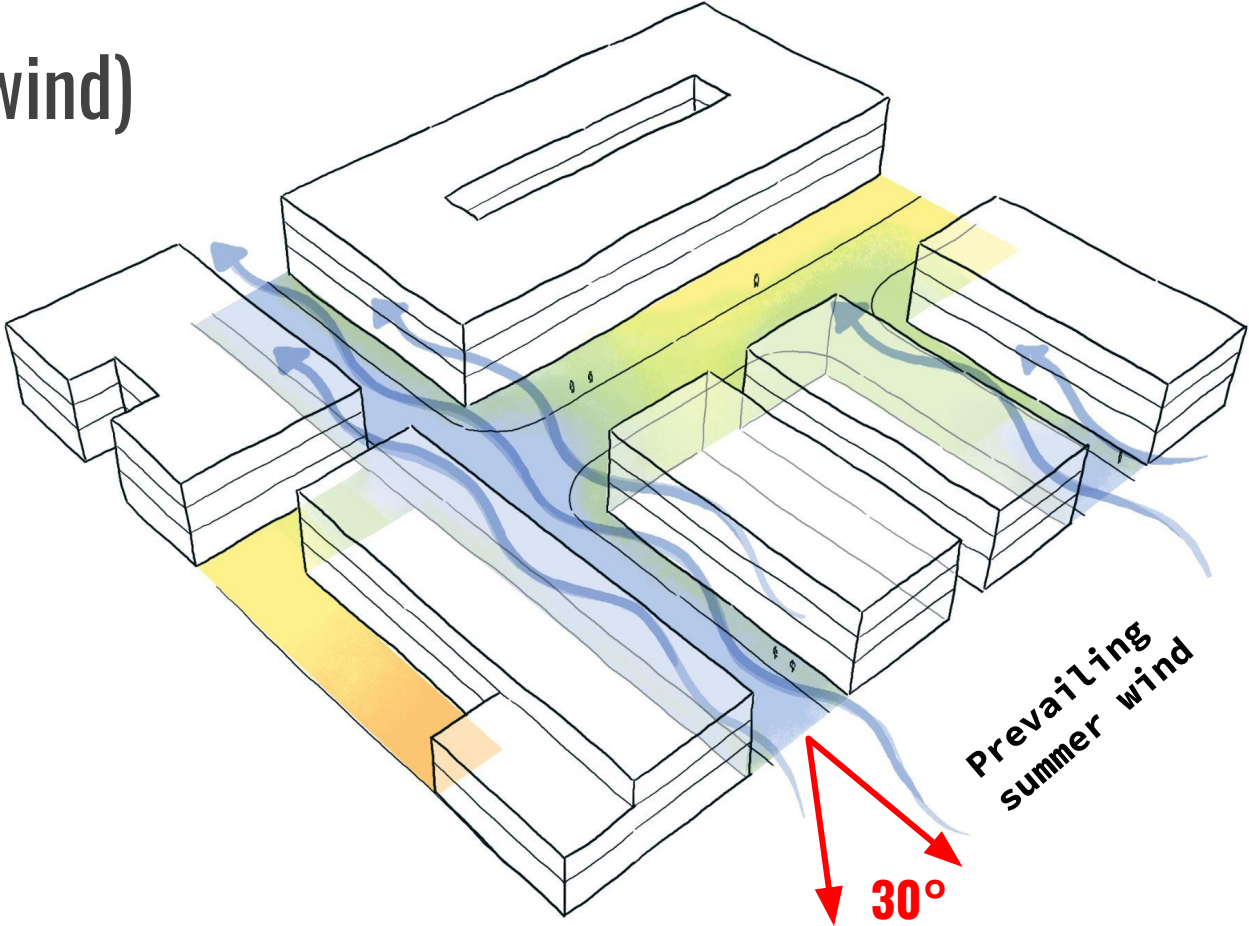
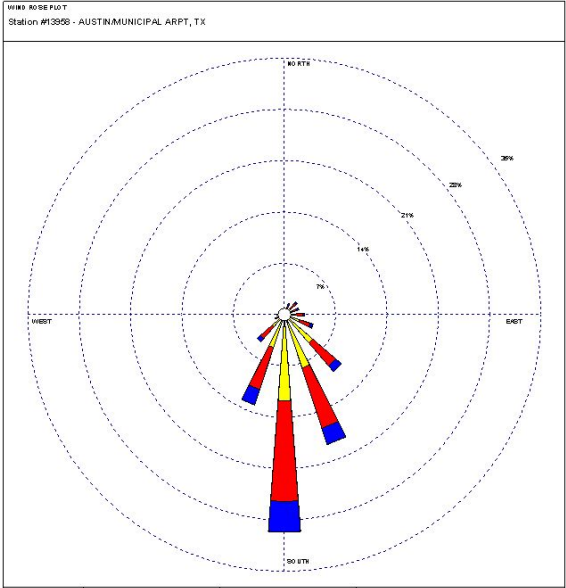
The landscape architect's response



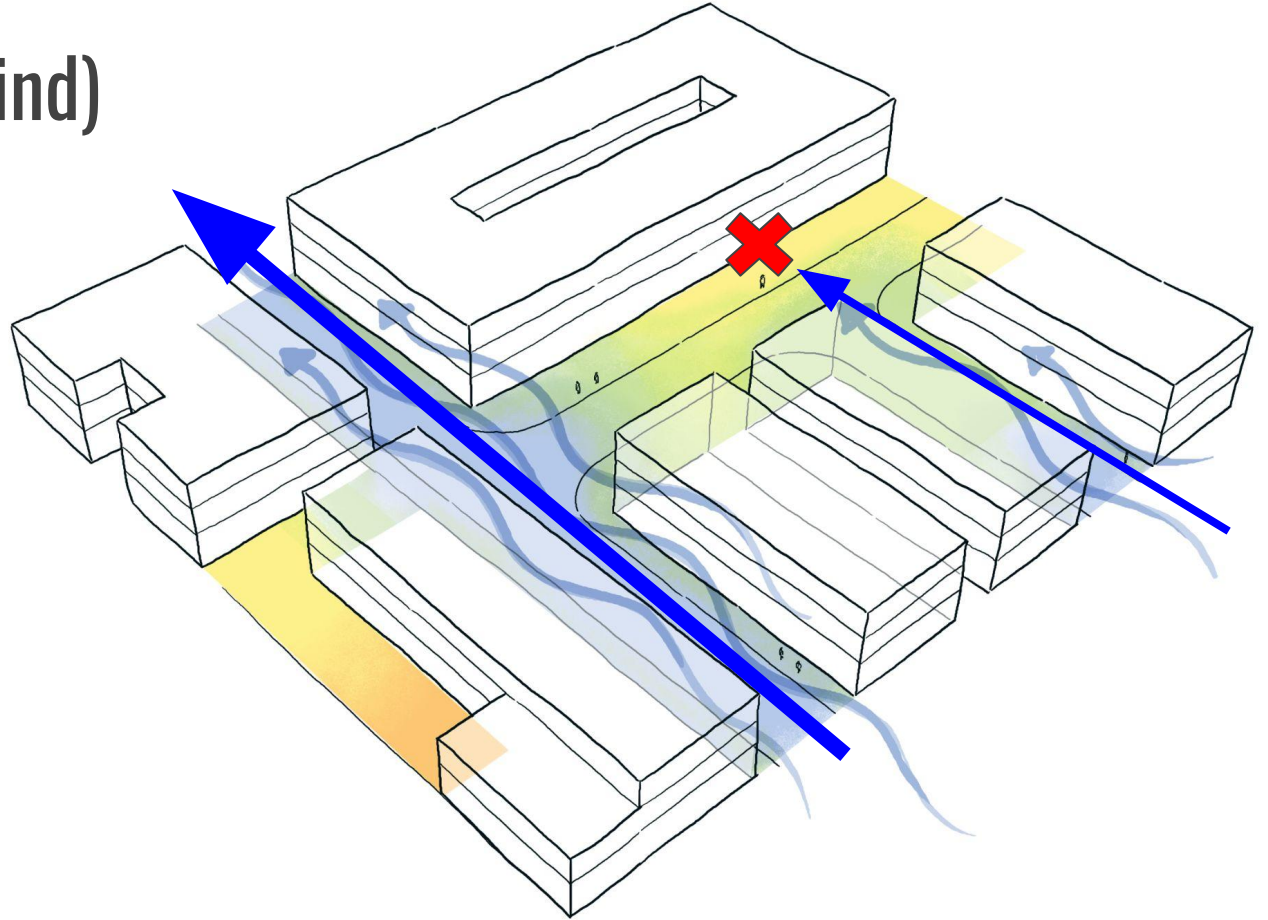
The UHI mitigation toolkit



Street orientation (wind)

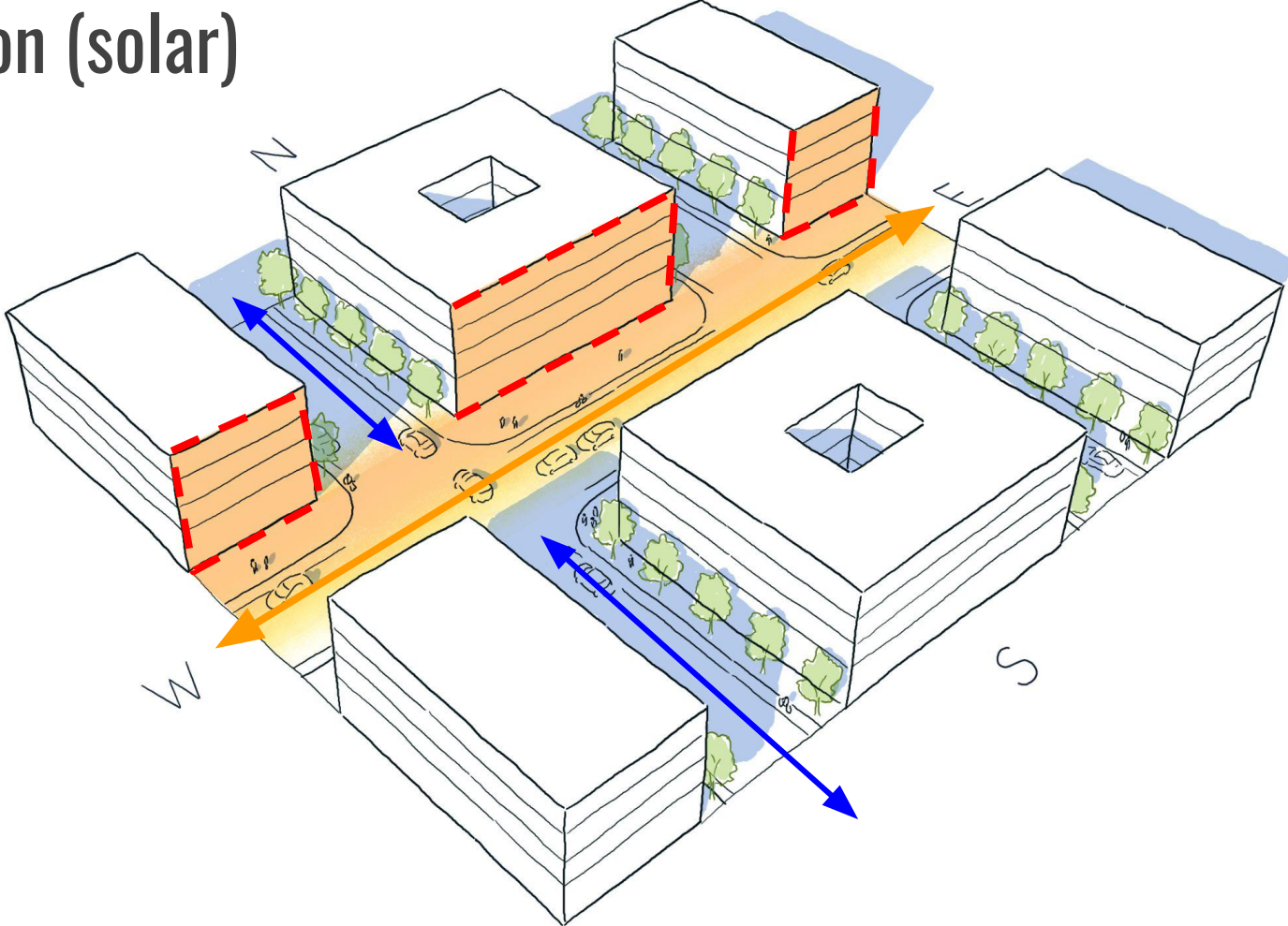


Street length (wind)

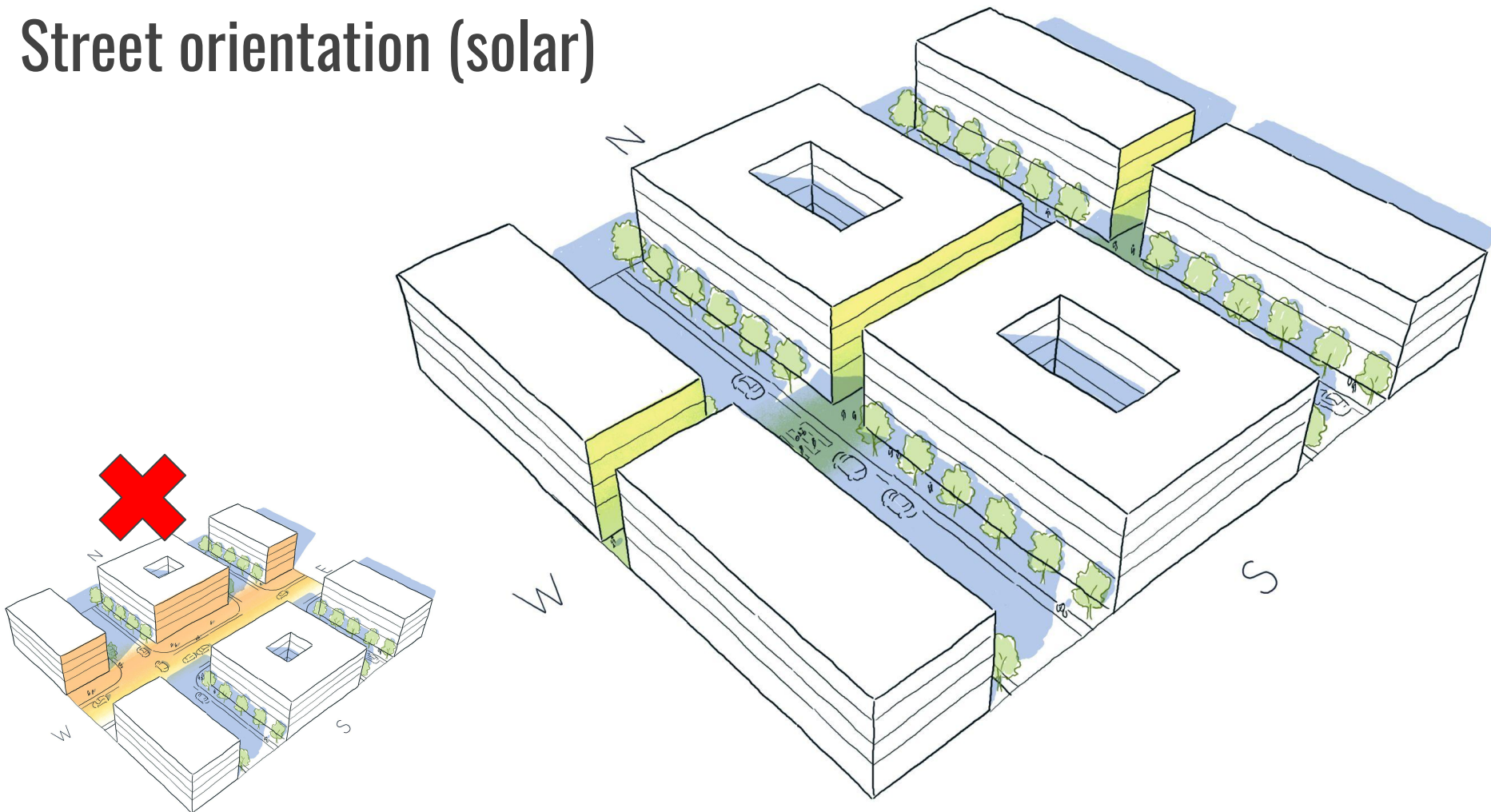




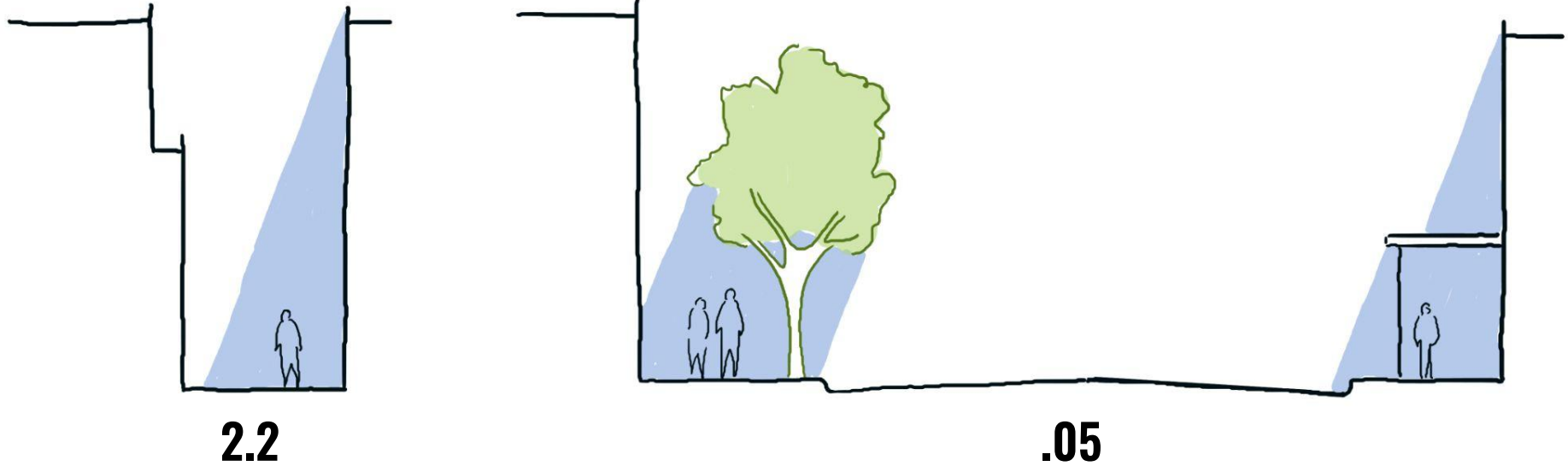
Street orientation (solar)



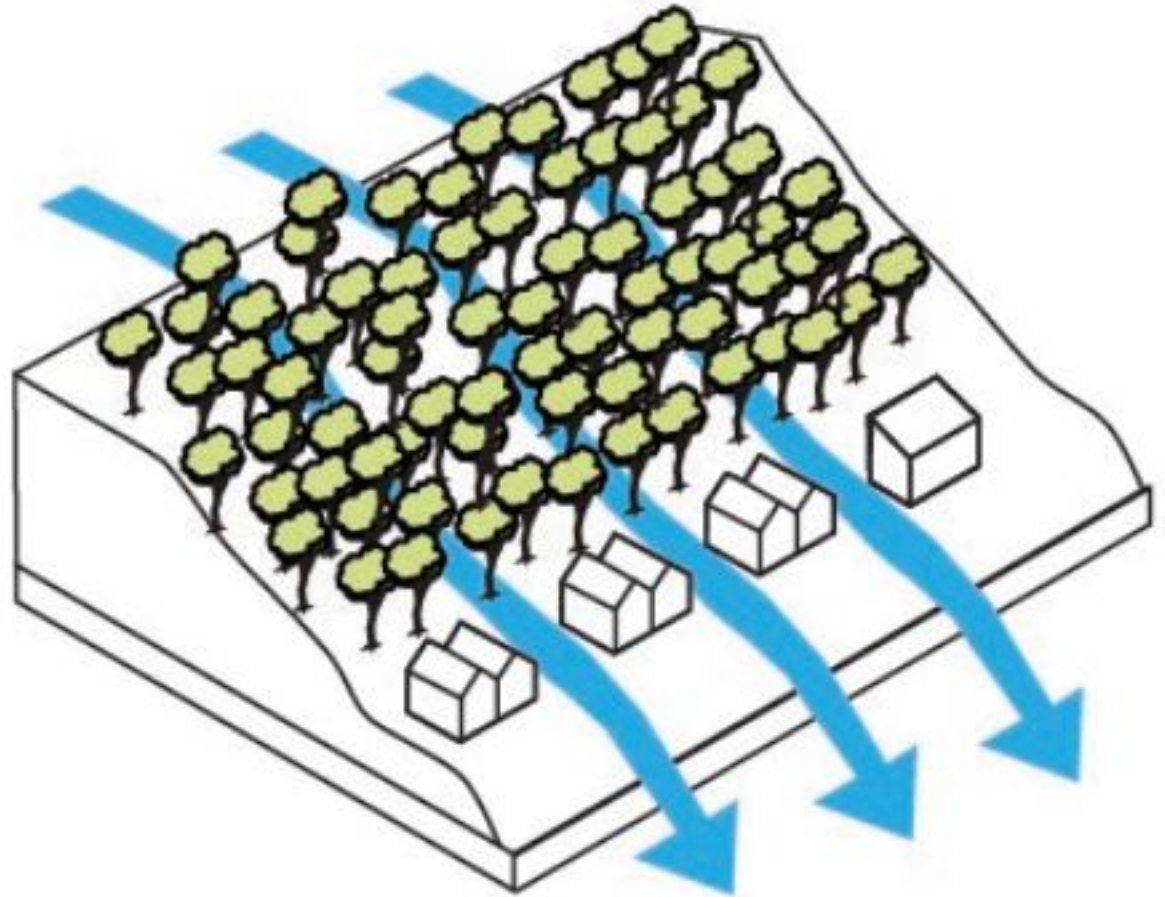
Street orientation (solar)



Urban canyon (H/W ratio)

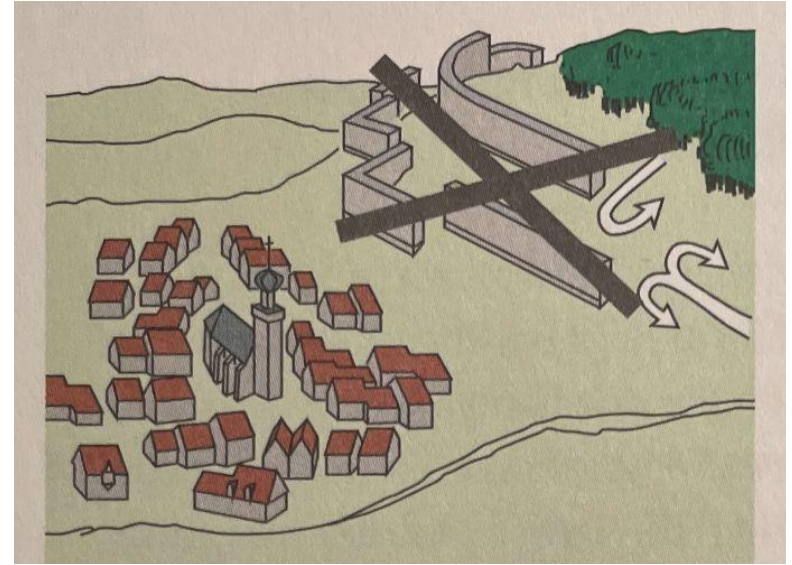


Downhill cooling





Facilitate downhill cooling

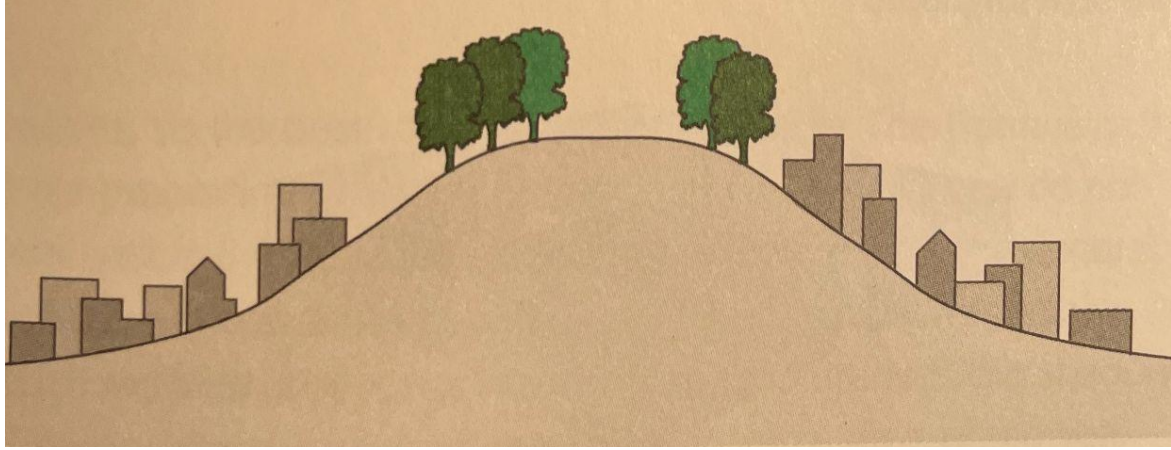


**Low walls and even hedgerows
can block slow moving air**

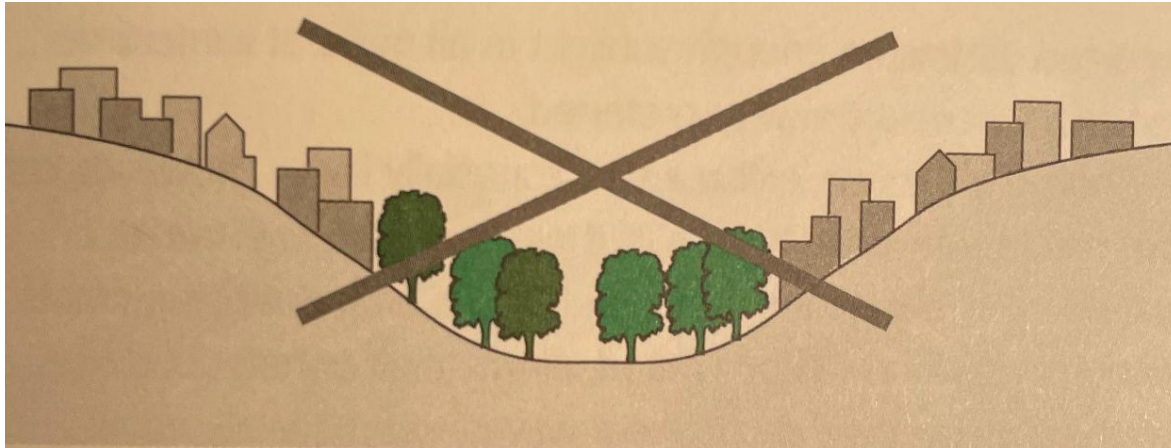


Image Landsat / Copernicus

Google Earth



**Ideal
preserve
location**



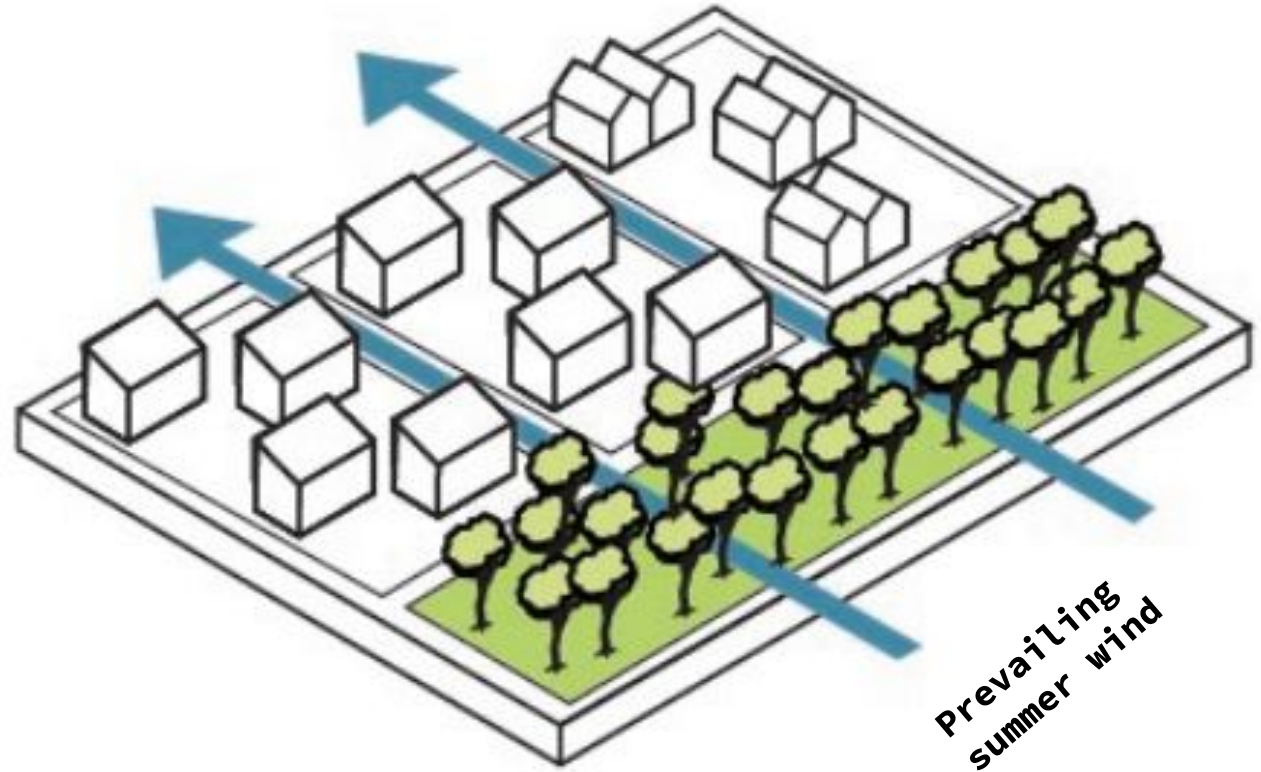
**Typical
preserve
location**

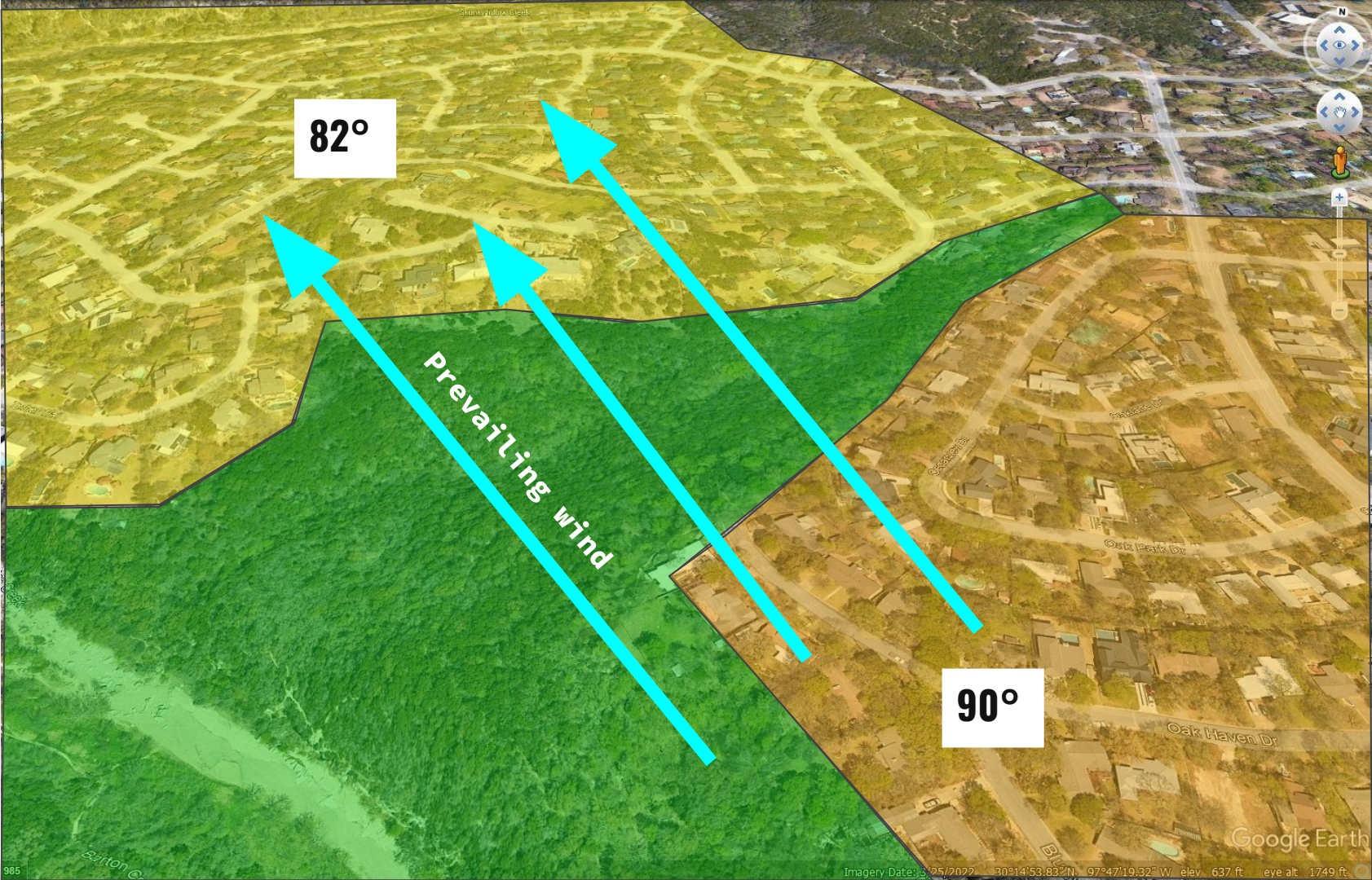


Image Landsat / Copernicus

Google Earth

Park cooling





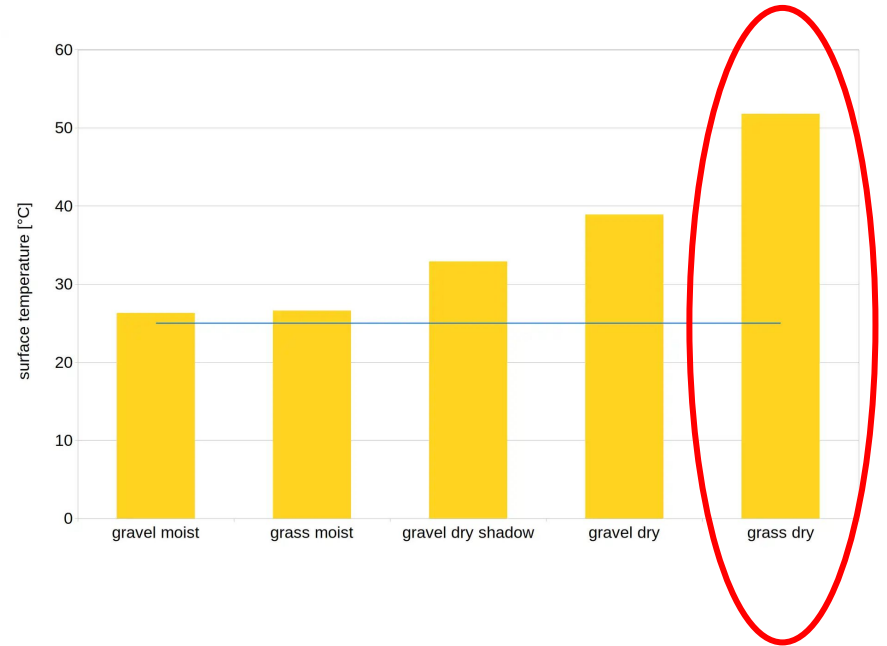
82°

Prevailing wind

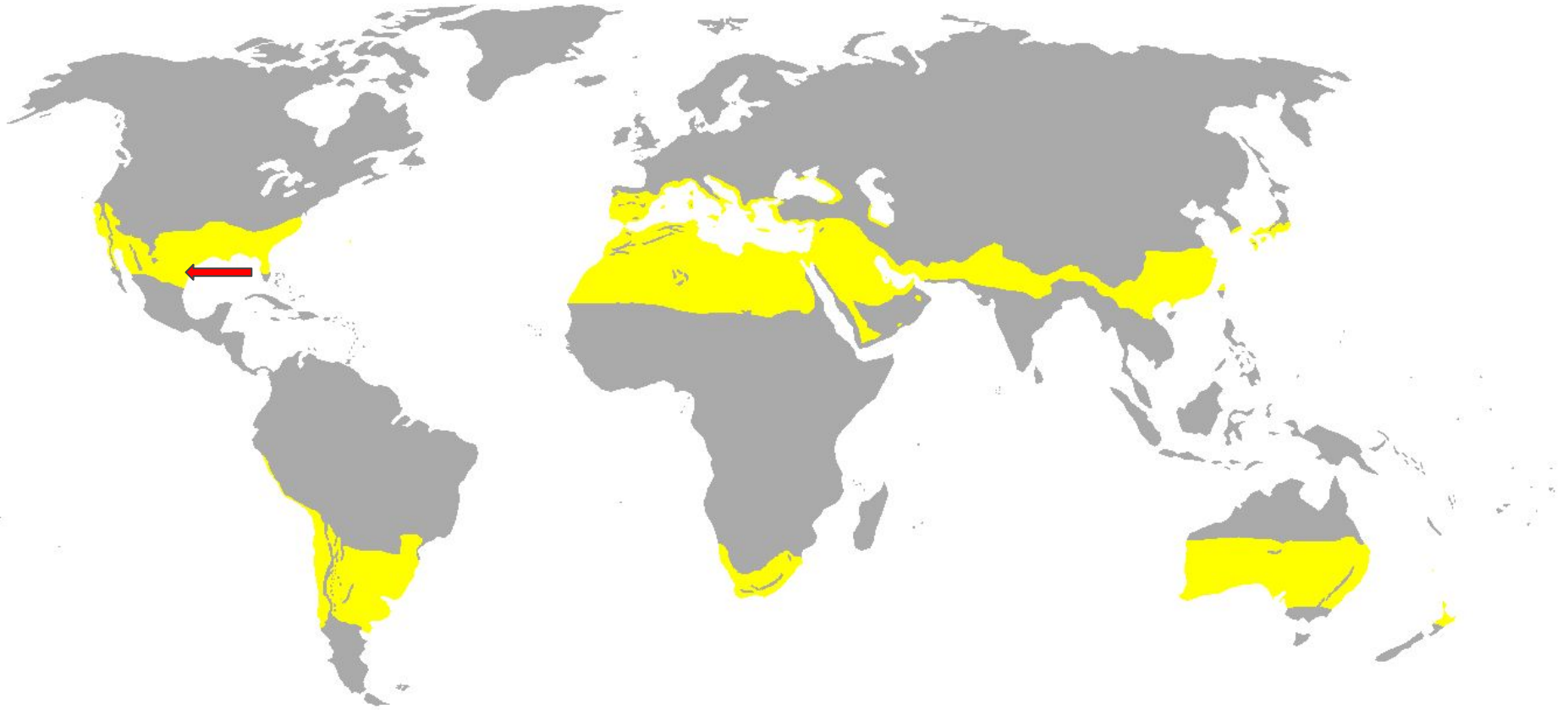
90°

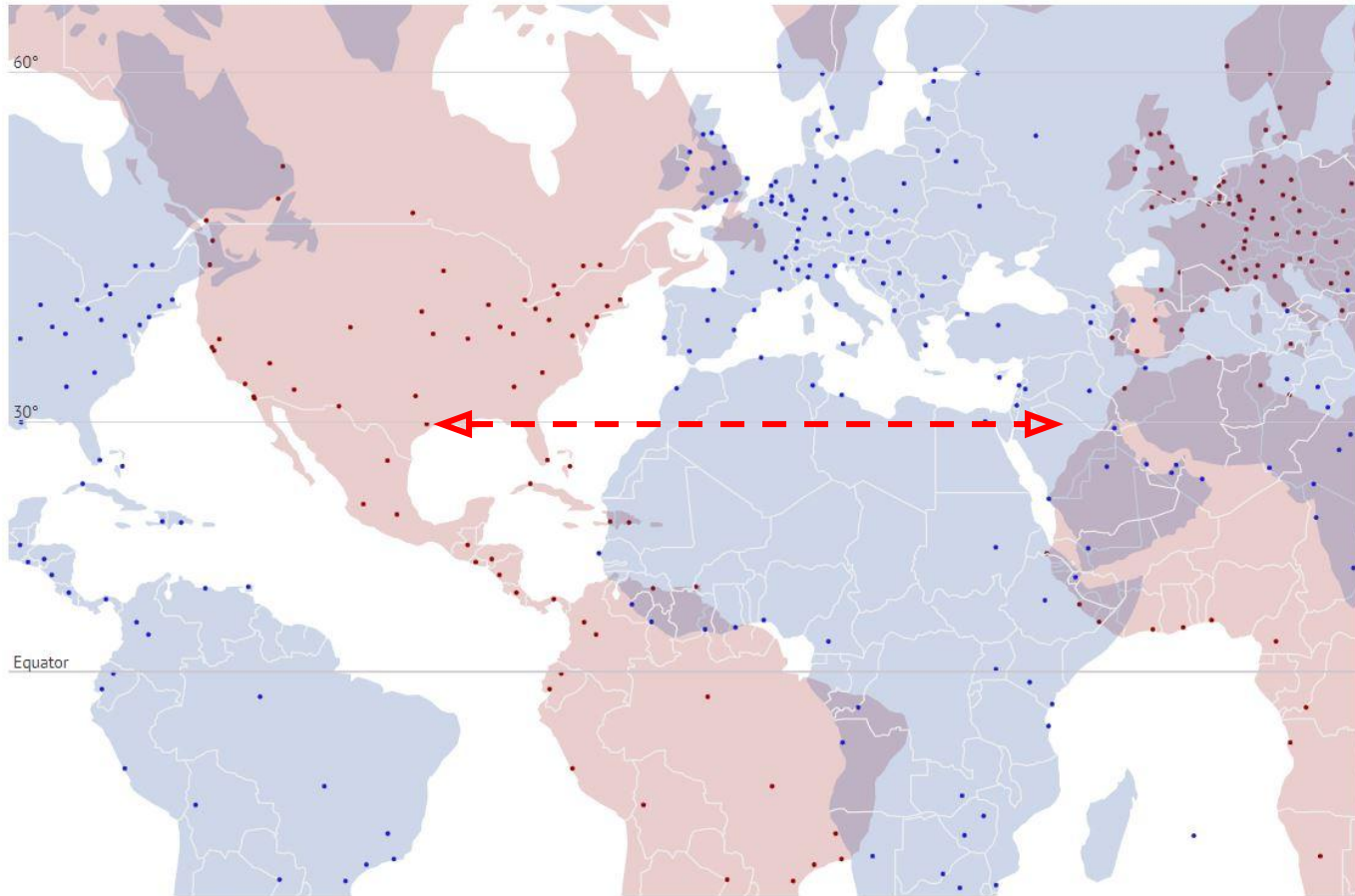


Source: Rheologic



The Texas climate context - subtropical





List of cities created using data from [Globalization and World Cities Research Network](#). Latitude and longitude calculated using [Google Geocoder](#). **Built using d3.js**.



List of cities created using data from *Globalization and World Cities Research Network*. Latitude and longitude calculated using *Google*

What can we learn from our climate sister cities?

Characteristics

- Extremely compact
- 2-4 stories high, inward courtyard
- Very narrow streets. H/W ratio
- Irregular street network, increases mutual shading by buildings







Fez Old City **80°**



Fez New City **93°**



Improving the medina model

Wider “civic streets”

Sun plazas

But we can't build like that!



Let's apply this as an intervention



TREE CANOPY



Per the City of Austin's Urban Forestry Department, this neighborhood has a lower than average tree canopy coverage. Austin's average canopy coverage is 31%. The "east side" neighborhood, which we have selected, is below average. Therefore, remediation of the tree canopy coverage in this area is a high priority for urban designers.

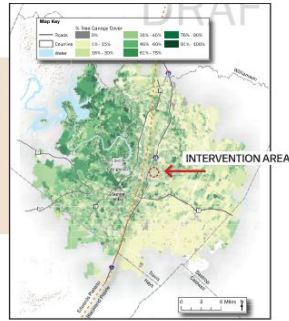


Figure 30



Figure 31

The site, and its immediate surroundings, have an elevated land surface temperature (urban heat island), compared to other residential areas east of downtown Austin.

Because of this elevated UHI, it is justifiable to focus UHI mitigation efforts when urban infill opportunities arise in this area.

EXISTING HEAT ISLAND



HOUSING DISCRIMINATION



Urban areas that were subject to historical patterns of discriminatory mortgage lending ("redlining") still carry an elevated burden today, decades after such policies officially ended. Studies have described neighborhoods targeted for discriminatory mortgage policies are "landscapes of thermal inequity".

Nearly all have elevated surface temperatures compared to their non-redlined neighbors. The disparities were found to be as much as 7° C. (Hoffman, et al 2020).

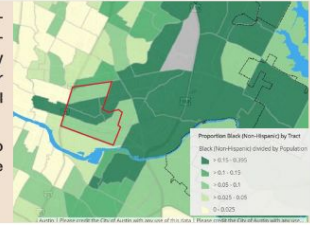
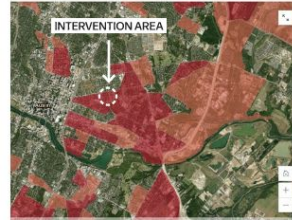


Figure 32



Climate change resiliency studies have evaluated Austin neighborhoods to determine where residents might be most vulnerable to the impacts of climate change and elevated temperatures.

The Heat Priority Index (HPI) combines all variables into a single metric. Areas highlighted here are in the top 20%. These are areas where Austin should focus its efforts to mitigate extreme heat (McCall 2021).

HIGH SOCIAL VULNERABILITY



PUBLIC HOUSING

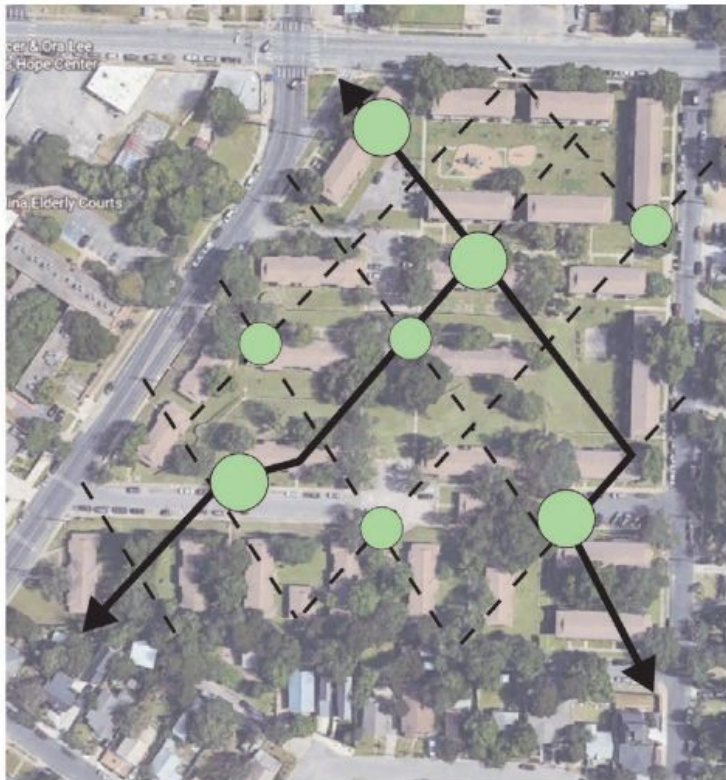





Rosewood Courts was chosen because it is scheduled for redevelopment and is currently undergoing a public comment period. Since much of the surrounding neighborhood is rapidly gentrifying, the MRP's UHI mitigation efforts are focused on public housing estates, which have a population that is more likely to be at risk of heat related illness according to Hoffman (2020).



Figure 34. The proposal for Rosewood Courts redevelopment

Applying the concept



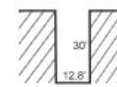
-  Civic sunlight street
-  Narrow canyon street
-  Sunlight & tree cooling plaza

Refined concept

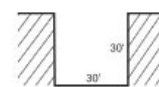


-  Civic streets
-  Narrow canyon streets
-  Sun plaza

Medina H/w Typologies



Narrow
H/w 2.2



Civic
H/w 1.0



Diagonal street grid for mutual solar shading

Narrow street. H/W 2.2

Civic street. H/W 1.0

Sun plazas with deciduous trees.
Allows light in winter. Provides shade in summer

Long street length (civic) facilitates wind velocity

Streets aligned within 30 degrees of summer wind direction (south)

Green roof at all buildings



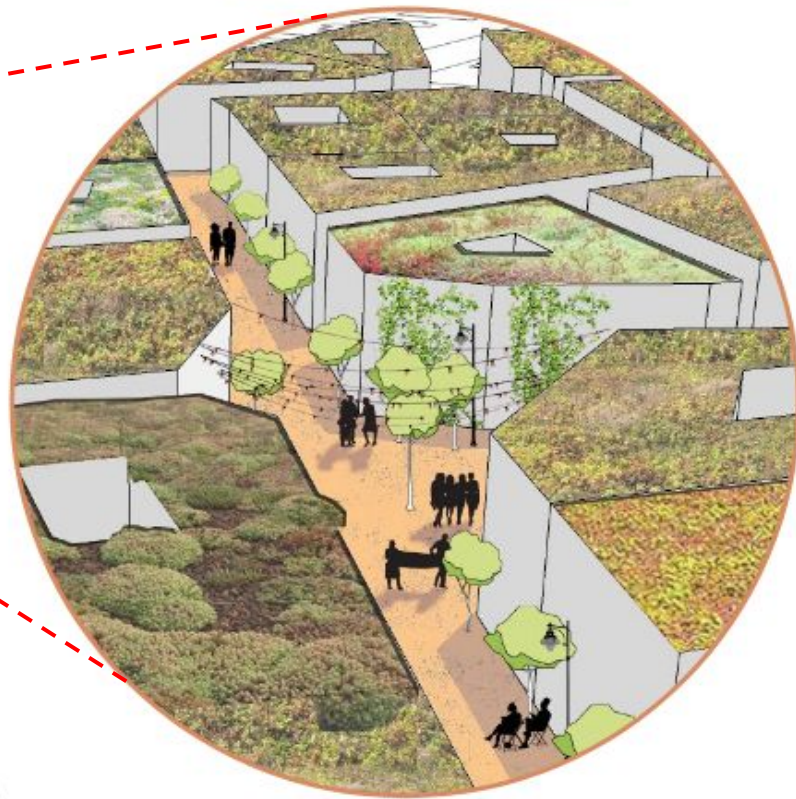
TREES & VEGETATION



URBAN FORM



Framework with all toolkit components



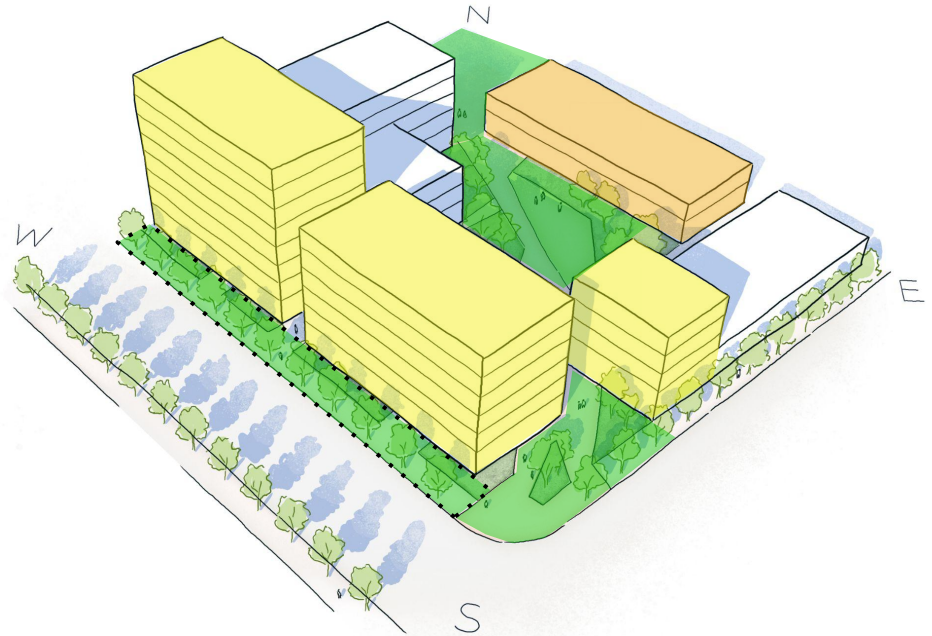
Shadow umbrella

Tall buildings on the west and south (fade in text w/ arrows)

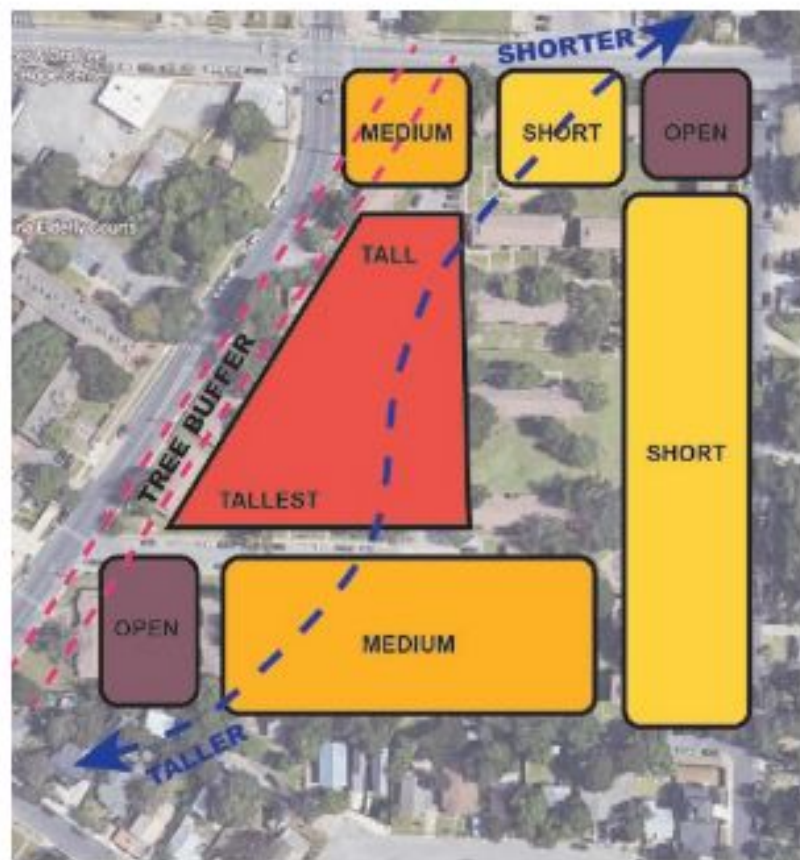
Shortest buildings on the east

Wide tree margin on the west

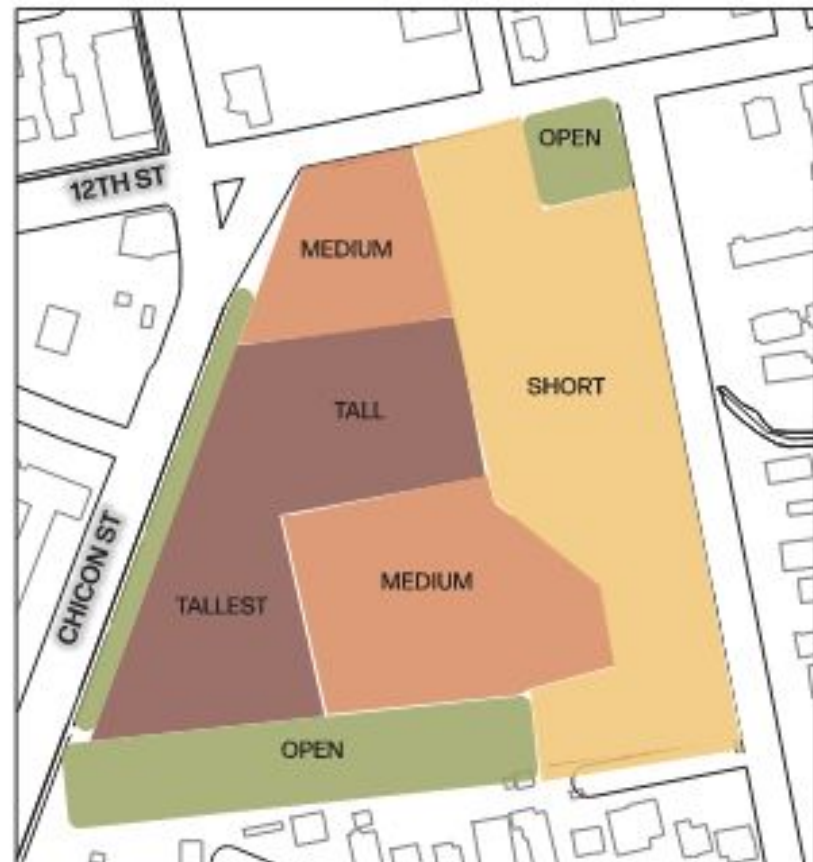
Open space at center of block, NE & SW corners



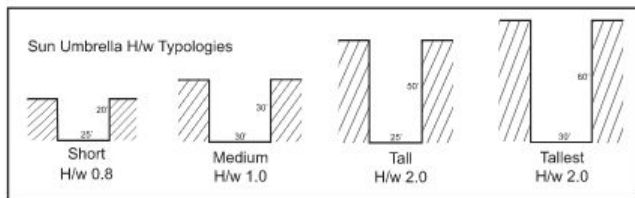
Concept



Refined concept



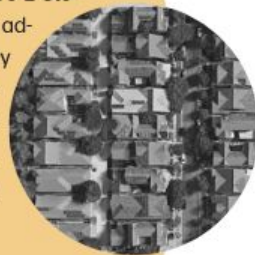
In this stage we continue our refinement of the physical form of the tall, medium, and short typologies. We also capture the tree massing located on the hilltop at the south of the site.



Typology Precedents

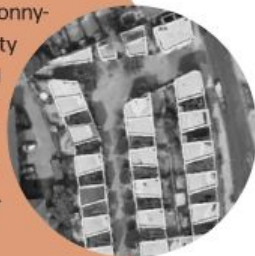
SHORT

These small (by American standards) cottages are 2 stories and include a garage which can be used as an additional dwelling unit. This typology can be readily found in Austin's Mueller development, a new urban development in a former airport. The streets are quite narrow for new construction in the USA, about 20' wide. This building typology is culturally familiar in the Austin context.



MEDIUM

This umbrella typology is inspired by London's Donnybrook Quarter. The low-rise (2-3 story) high-density residential quarter is spatially organized around intimately proportioned streets and small plazas, and has proportions similar to traditional Arab-Muslim cities. This typology is unusually compact in the Austin context, but it does allow for vehicular access.



TALL (est)

This fairly generic 5-6 stories tower typology is inspired by numerous public housing estates in Europe. This typology is fairly common in the Austin context, though there is often a lot of surface of underground parking associated with it.





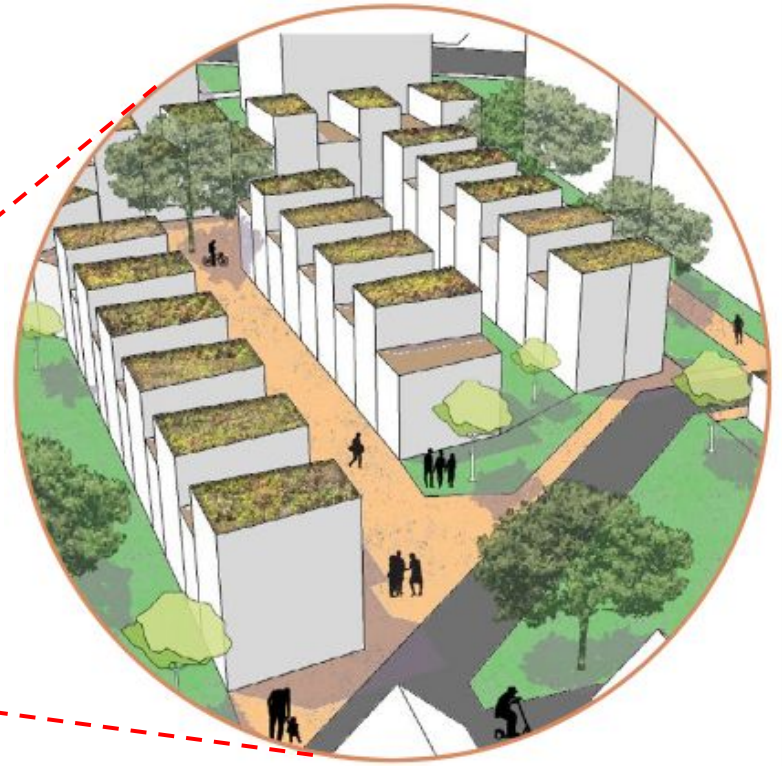
- Tree canopy. Most existing trees preserved
- East-west oriented paths are narrow to reduce solar exposure
- Additional trees at western edge for solar protection
- Urban canyon. H/W 0.8 min
- North-south oriented streets are cooler. No East-West streets
- Long street segments for wind orientation
- Streets aligned with summer wind direction (south)
- Downhill cooling/ Park cooling islands preserved and enhanced



- Green roof
- New trees to fill canopy gaps



Plan view with all toolkit mechanisms applied

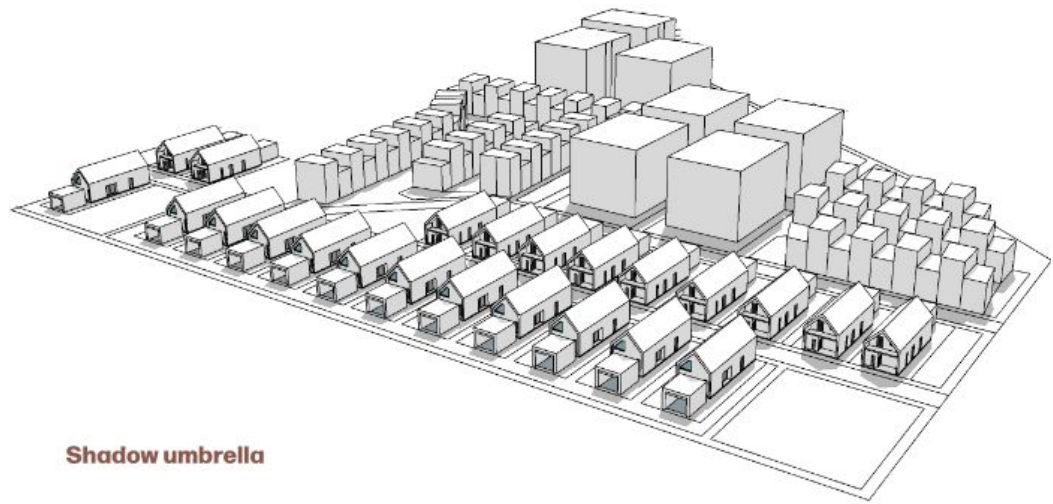


Thermal analysis

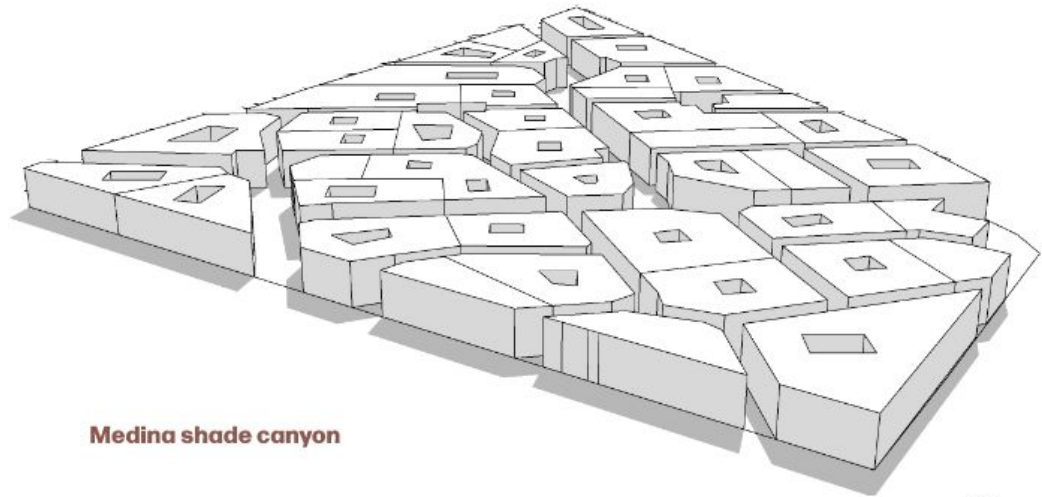
Courtesy of



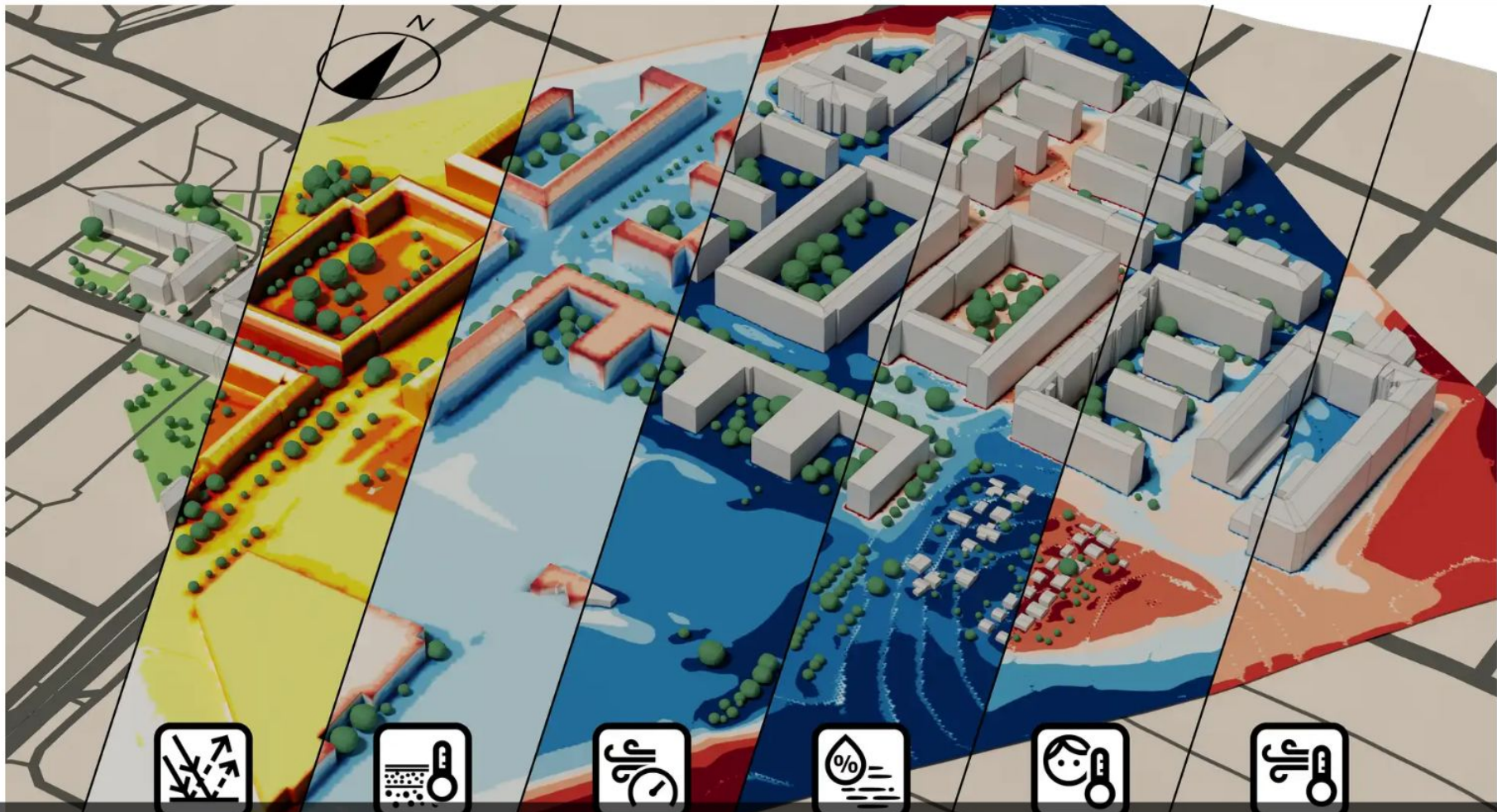
Rheologic



Shadow umbrella

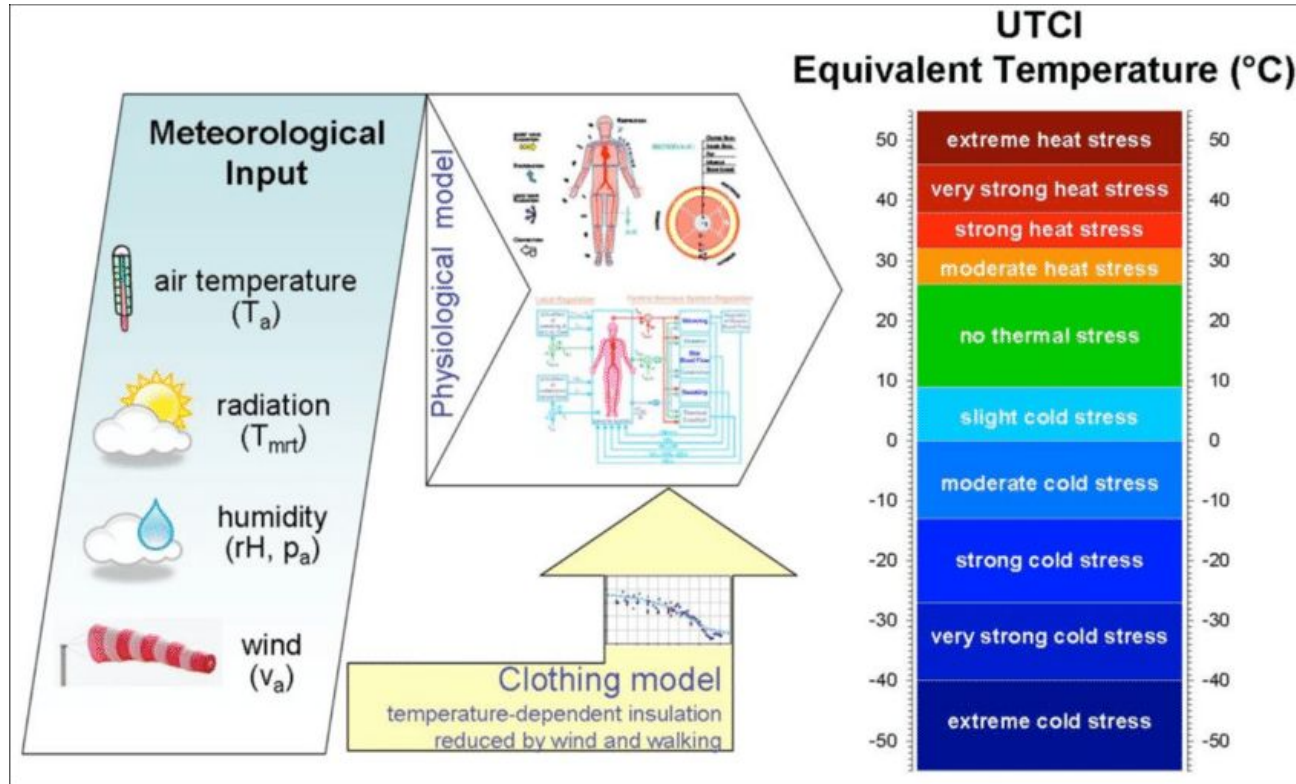


Medina shade canyon

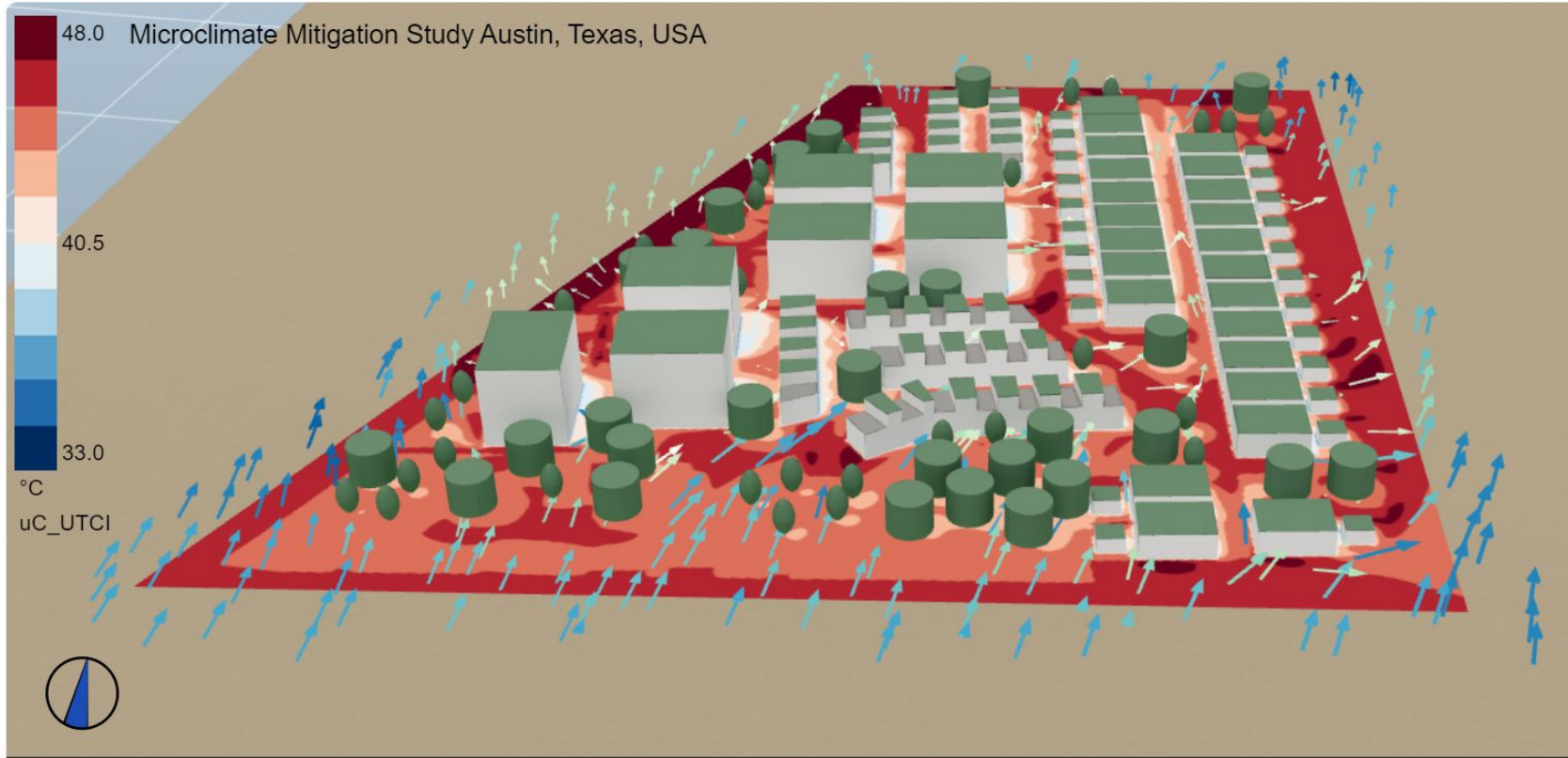


Urban wind and microclimate simulation. One model full of information: evaporative cooling, air temperature, apparent temperature, surface temperature, solar radiation

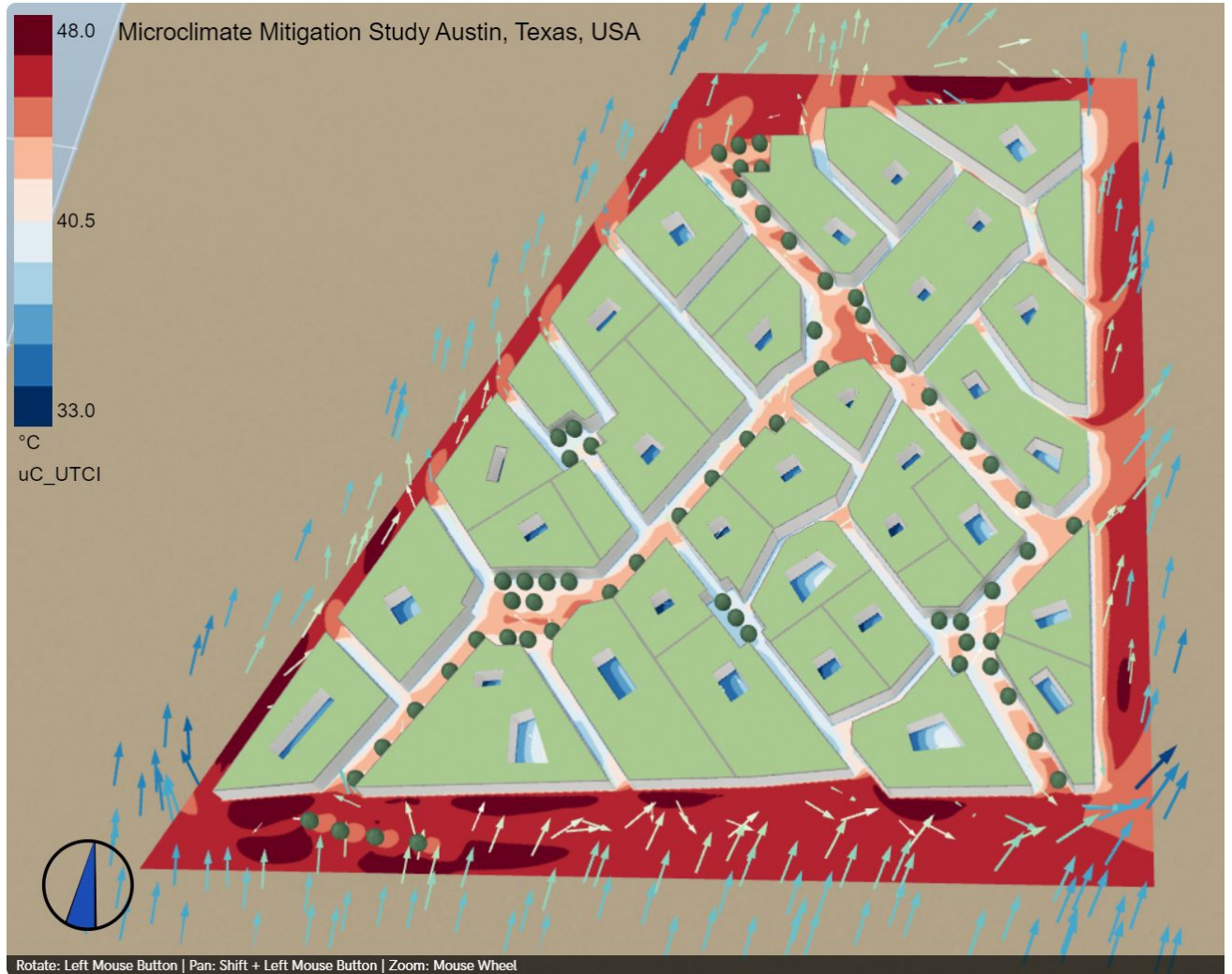
Universal Thermal Climate Index (UTCI)



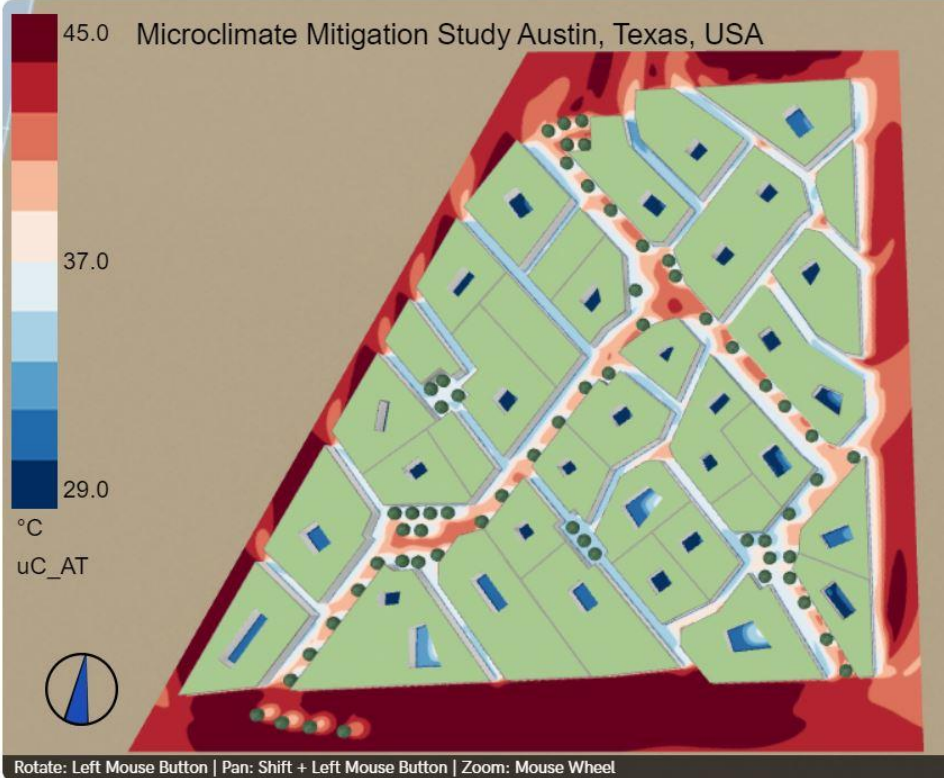
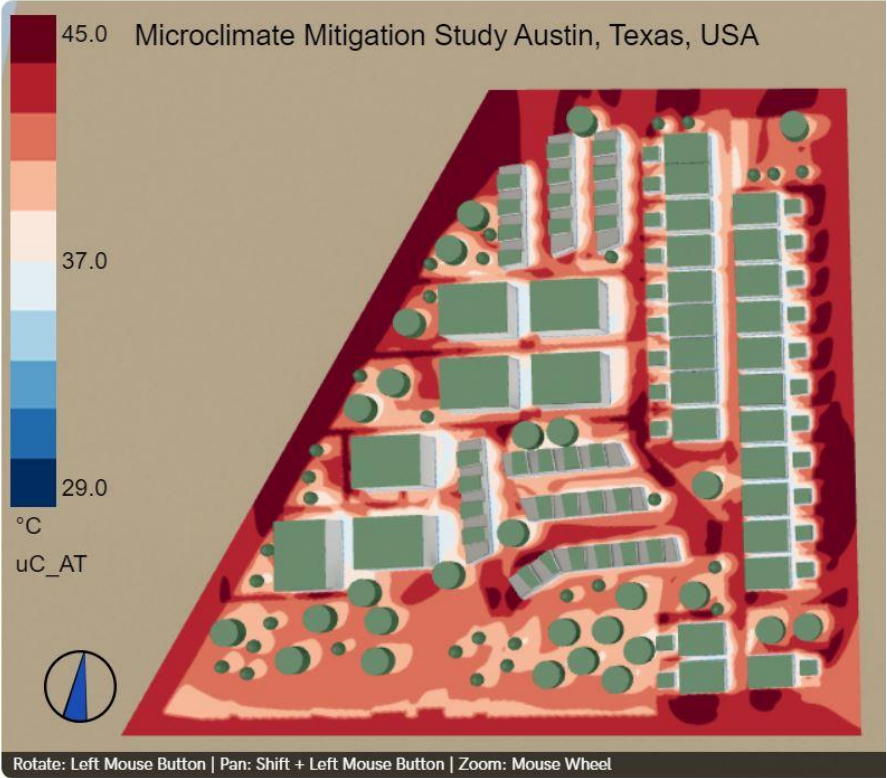
UTCI + Wind



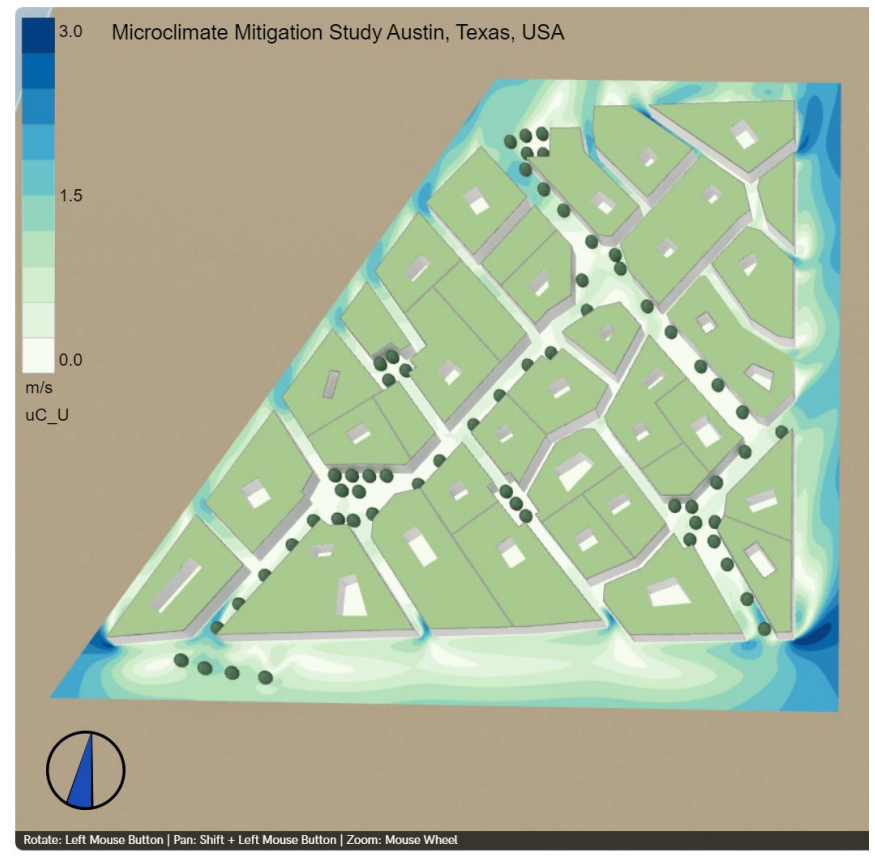
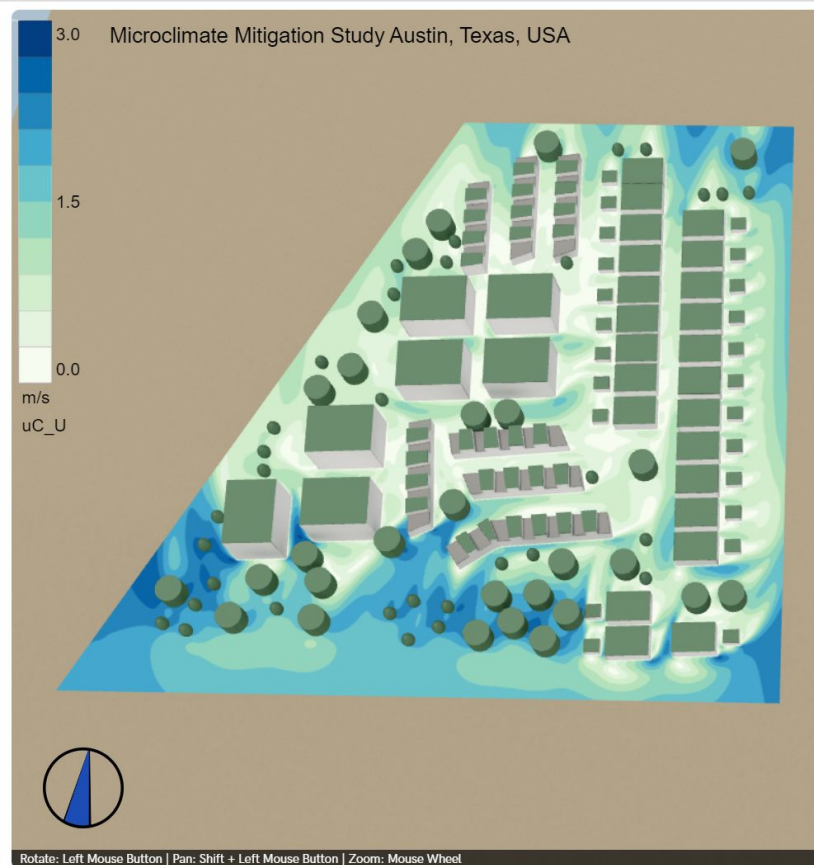
UTCI + Wind



UTCI



Wind



How can we better use this?



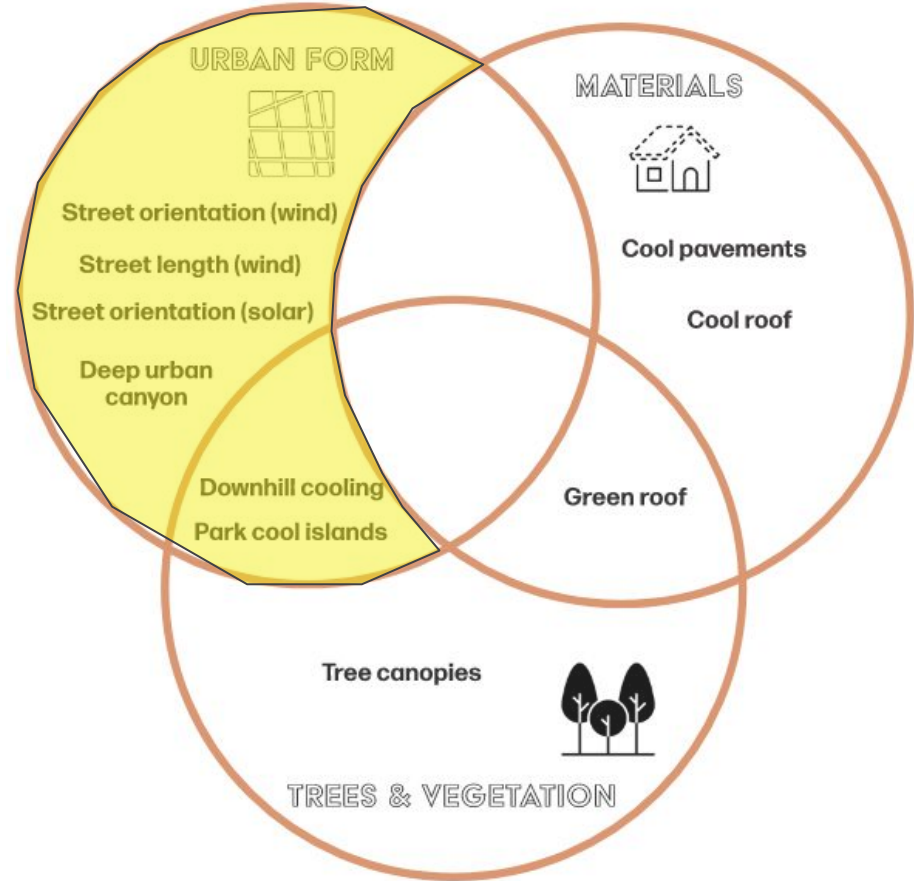
LEED v4 for BD+C: New Construction and Major Renovation Project Checklist

Y ? N

Y	?	N	Credit	Integrative Process	1
---	---	---	--------	---------------------	---

0	0	0	Location and Transportation	16	
Y			Credit	LEED for Neighborhood Development Location	16
Y			Credit	Sensitive Land Protection	1
Y			Credit	High Priority Site	2
Y			Credit	Surrounding Density and Diverse Uses	5
Y			Credit	Access to Quality Transit	5
Y			Credit	Bicycle Facilities	1
Y			Credit	Reduced Parking Footprint	1
Y			Credit	Green Vehicles	1

0	0	0	Sustainable Sites	10	
Y			Prereq	Construction Activity Pollution Prevention	Required
Y			Credit	Site Assessment	1
Y			Credit	Site Development - Protect or Restore Habitat	2
Y			Credit	Open Space	1
Y			Credit	Rainwater Management	3
Y			Credit	Heat Island Reduction	2
Y			Credit	Light Pollution Reduction	1



Time for a “heat czar?”



Phoenix’s Office of Heat Response and Mitigation (OHRM or HeatReadyPHX) is leading the efforts of the hottest large city in the United States to fight the growing hazard of urban heat. OHRM focuses on both heat response (helping people cope with hot weather) and heat mitigation (cooling the city and making it more comfortable).

During all seasons of the year, HeatReadyPHX coordinates programs and policies to help lower urban temperatures and protect public health. It also tracks trends, collects data, and collaborates with other governments and organizations to share ideas and solutions when it comes to dealing with heat.



Conclusions

- UHI mitigation is complex! There's no magic bullet.
- Need a combination of urban design, materials, and trees & vegetation
- SHADE
- Trees are part of the answer, but they can inhibit wind velocity & radiative cooling.
- Valuable built environment lessons from other cultures, such as the middle eastern medina morphology.
- Landscape architects have a valuable role

Special thanks to...

Dissertation support by:

Colin Hayes, Visiting Professor



THE BARTLETT

UHI analysis by:



<https://rheologic.net/>

office@rheologic.net

Thanks for coming to my TED Talk

