Architecture & Urban Design to Address Climate & Health Crises


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MILLER SCHOOL of MEDICINE
DEPARTMENT of PUBLIC HEALTH SCIENCES
SCHOOL of ARCHITECTURE
COLLEGE of ARTS AND SCIENCES
MIAMI-DADE COUNTY

Extreme heat

More frequent

More intense

Heavy rainfall

More frequent

More intense

Drought

Increase in some regions

Fire weather

More frequent

Ocean

Warming

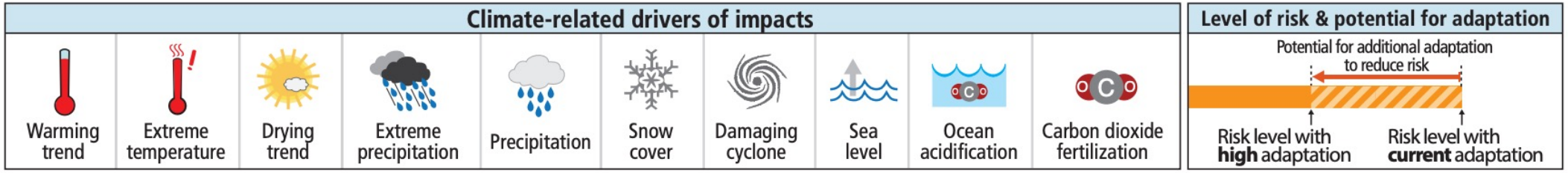
Acidifying

Losing oxygen

Photo Credits from left: 1. Luiz Guimaraes 2. Jonathan Ford 3. Peter Burdon 4. Ben Kuo 5. NOAA; https://www.ipcc.ch/report/ar6/wg1/downloads/outreach/IPCC_AR6_WGI_Press_Conference_Slides.pdf; *IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press.

Adaptation

Key regional risks from climate change and the potential for reducing risks through adaptation and mitigation

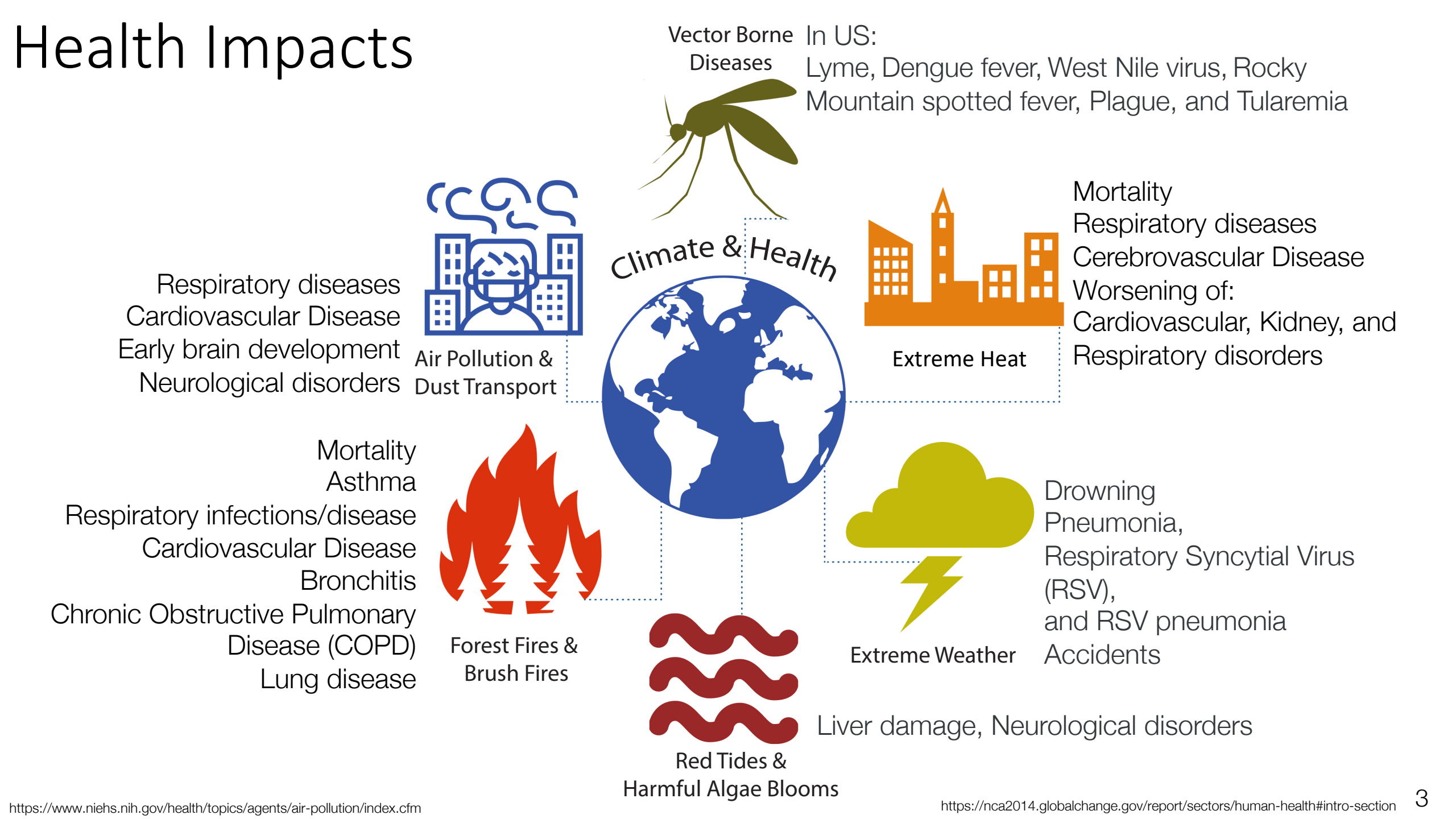


North America

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
Wildfire-induced loss of ecosystem integrity, property loss, human morbidity, and mortality as a result of increased drying trend and temperature trend (*high confidence*) [26.4, 26.8, Box 26-2]	• Some ecosystems are more fire-adapted than others. Forest managers and municipal planners are increasingly incorporating fire protection measures (e.g., prescribed burning, introduction of resilient vegetation). Institutional capacity to support ecosystem adaptation is limited. • Adaptation of human settlements is constrained by rapid private property development in high-risk areas and by limited household-level adaptive capacity. • Agroforestry can be an effective strategy for reduction of slash and burn practices in Mexico.		Present Near term (2030–2040) Long term (2080–2100) 2°C / 4°C	Very low / Medium / Very high
Heat-related human mortality (*high confidence*) [26.6, 26.8]	• Residential air conditioning (A/C) can effectively reduce risk. However, availability and usage of A/C is highly variable and is subject to complete loss during power failures. Vulnerable populations include athletes and outdoor workers for whom A/C is not available. • Community- and household-scale adaptations have the potential to reduce exposure to heat extremes via family support, early heat warning systems, cooling centers, greening, and high-albedo surfaces.		Present Near term (2030–2040) Long term (2080–2100) 2°C / 4°C	Very low / Medium / Very high
Urban floods in riverine and coastal areas, inducing property and infrastructure damage; supply chain, ecosystem, and social system disruption; public health impacts; and water quality impairment, due to sea level rise, extreme precipitation, and cyclones (*high confidence*) [26.2-4, 26.8]	• Implementing management of urban drainage is expensive and disruptive to urban areas. • Low-regret strategies with co-benefits include less impervious surfaces leading to more groundwater recharge, green infrastructure, and rooftop gardens. • Sea level rise increases water elevations in coastal outfalls, which impedes drainage. In many cases, older rainfall design standards are being used that need to be updated to reflect current climate conditions. • Conservation of wetlands, including mangroves, and land-use planning strategies can reduce the intensity of flood events.		Present Near term (2030–2040) Long term (2080–2100) 2°C / 4°C	Very low / Medium / Very high

IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 23., https://www.ipcc.ch/site/assets/uploads/2018/02/ar5_wgII_spm_en.pdf

Health Impacts



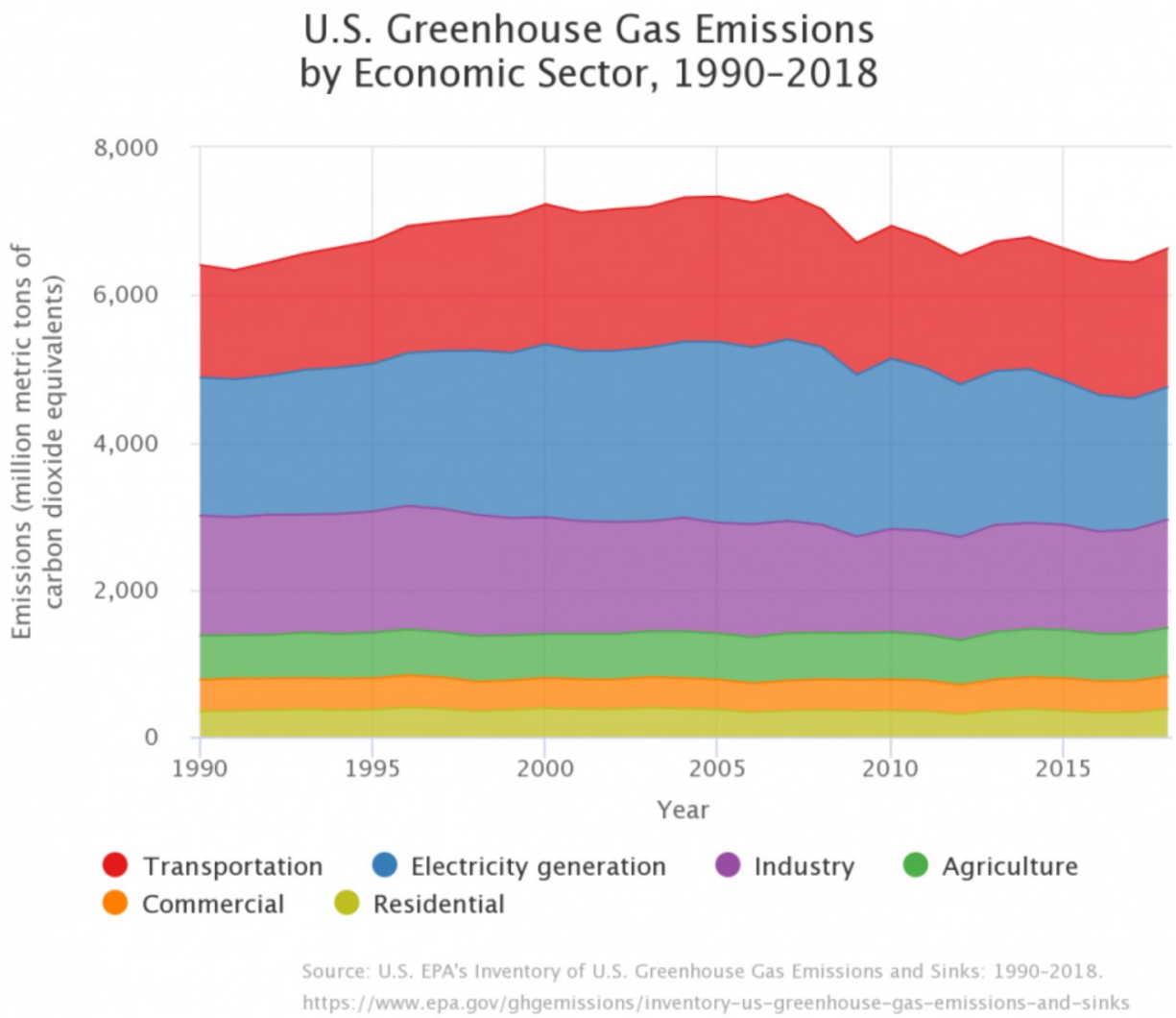
https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm

https://nca2014.globalchange.gov/report/sectors/human-health#intro-section

Built Environment Mitigation

The urban built environment is responsible for **75%** of annual global GHG emissions: buildings alone account for **39%.** Eliminating these emissions is the key to addressing climate change and meeting Paris Climate Agreement targets.

Architecture 2030.org



https://architecture2030.org/2030_challenges/2030-challenge/

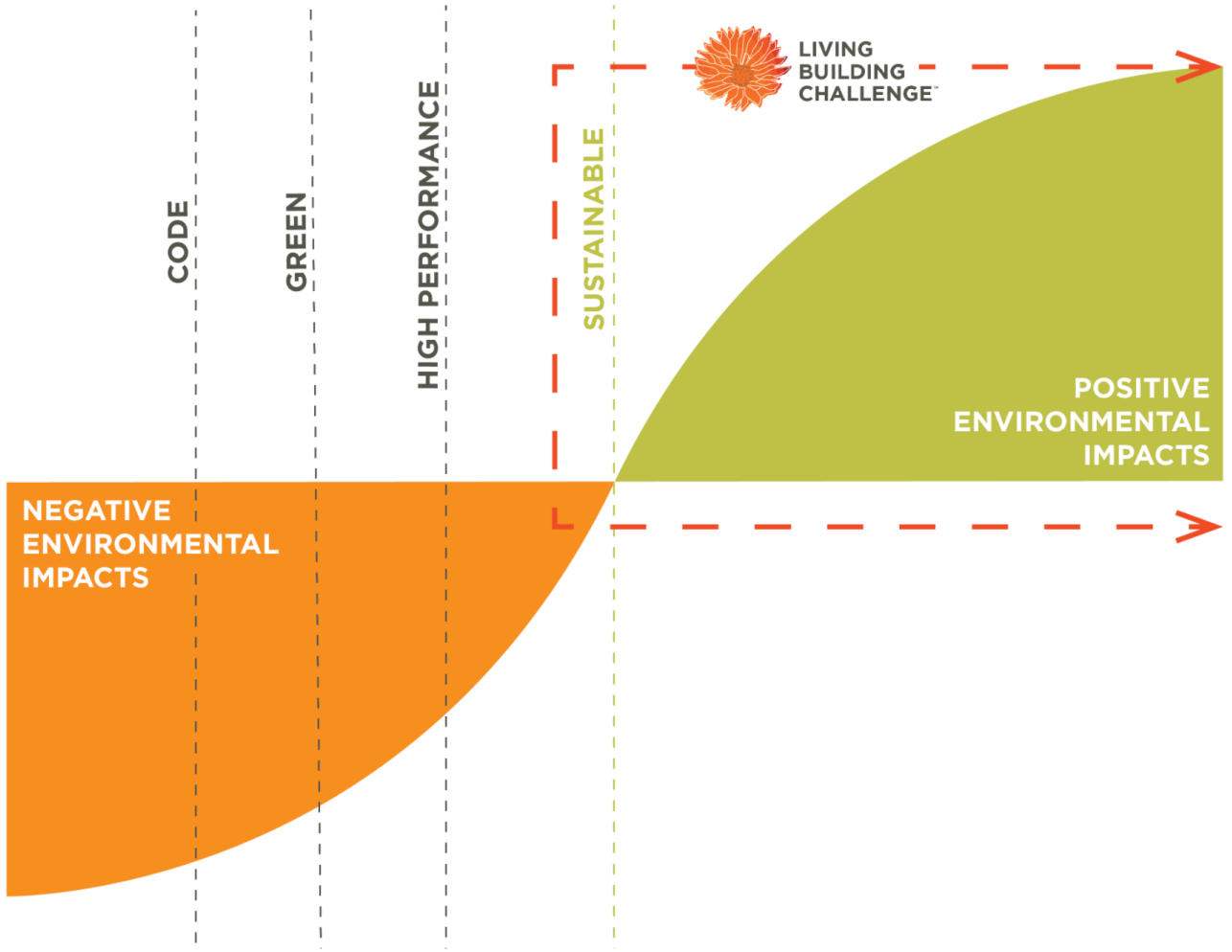
Built Environment Mitigation

The **ZERO Code** provides a national and international framework for building energy standards for new building construction that integrates cost-effective energy efficiency standards with on-site and/or off-site renewable energy support the construction of zero carbon buildings. It includes prescriptive and performance paths for building energy efficiency compliance based on the highest performing national standards that are available to municipalities and building professionals worldwide.

The **ZERO Code** applies to new commercial, institutional, and mid- to high-rise residential buildings, the dominant building types being constructed in cities today.

A Zero Carbon Building

is a highly efficient building that uses no on-site fossil fuels and produces on-site, or procures, enough carbon free renewable energy to meet building operational energy consumption annually.



http://www.zero-code.org/ABOUT/

https://living-future.org/lbc/basics4-0/

Built Environment Mitigation

SUMMARY MATRIX

20 Imperatives
Seven Petals

- CORE IMPERATIVE
- SCALE JUMPING ALLOWED
- HANDPRINTING IMPERATIVE
- IMPERATIVE REQUIRED FOR TYPOLOGY
- REQUIREMENT DEPENDENT ON SCOPE
- NOT REQUIRED FOR TYPOLOGY

PETAL	IMPERATIVE	TYPOLOGY: New Building	Existing Building	Interior	Landscape + Infrastructure
PLACE	1 Ecology of Place	■	▨		■
	2 Urban Agriculture	■	■		
	3 Habitat Exchange	■	■	■	■
	4 Human Scaled Living	■	▨	▨	
WATER	5 Responsible Water Use	■	■	■	■
	6 Net Positive Water	■	■		■
ENERGY	7 Energy + Carbon Reduction	■	■	■	■
	8 Net Positive Energy	■	■	■	■
HEALTH + HAPPINESS	9 Healthy Interior Environment	■	■	■	
	10 Healthy Interior Performance	■	■	■	
	11 Access to Nature	■	■	■	
MATERIALS	12 Responsible Materials	■	■	■	■
	13 Red List	■	■	■	■
	14 Responsible Sourcing	■	■	■	■
	15 Living Economy Sourcing	■	■	■	■
	16 Net Positive Waste	■	■	■	■
EQUITY	17 Universal Access	■	▨	▨	▨
	18 Inclusion	■	■	■	■
BEAUTY	19 Beauty + Biophilia	■	■	■	■
	20 Education + Inspiration	■	■	■	■

https://living-future.org/lbc/basics4-0/

Adaptation & Health

Building Design Strategies to Reduce Heat Impacts

Site Design
Orientation for air flow & shade
Landscape

Building Design
Orientation
Configuration

Building Systems
Passive cooling
Efficient mechanical systems

Material Choices
Color/Reflectance
Cool pavements
Cool roofs
Green roofs

Frick Environmental Center

City of Pittsburgh & Pittsburgh Parks Conservancy

AIA 2019 COTE® Top Ten

LEED Platinum

Living Building-Certified

Architect: Bohlin Cywinski Jackson
Construction Manager: PJ Dick
Civil Eng: H.F. Lenz Company
MEP Eng: RAMTECH
Structural Eng Barber & Hoffman
Landscape Architect:
LaQuatra Bonci and Associates
Stormwater Management: Nitsch Engineering
Sustainability Consult: Atelier Ten
Client Sustainability Cnslt: Evolve EA (2014)

https://www.aia.org/showcases/6130374-frick-environmental-center

Adaptation & Health

Neighborhood Design Strategies to Reduce Heat Impacts

Greenness
Street Trees
Parks
Gardens

Mobility
Mixed Use
Connectivity
Walkability

Active Cooling
Misters
Cooling Centers

One-Minute City
&
Street Moves

Dan Hill
Vinnova
Sweden's
Innovation
Agency

Director of Strategic Design, Vinnova
Vstg.Prof., UCL IIPP
Adjt. Prof., RMITUniversity
@cityofsound
medium.com/@cityofsound

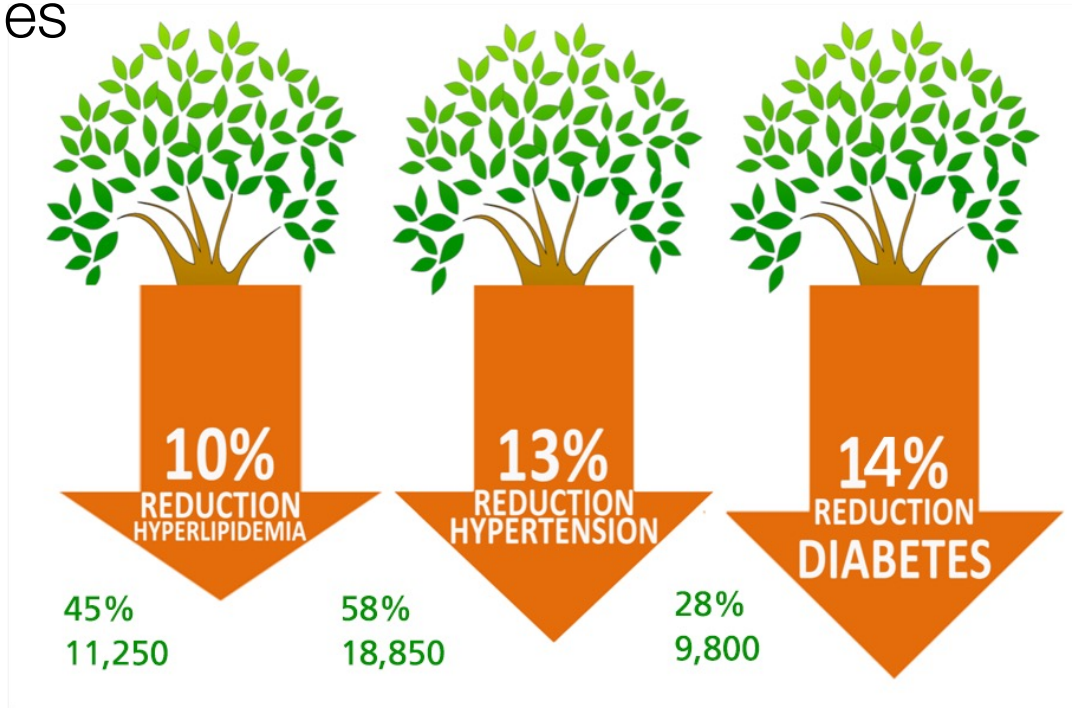
https://www.iqs.se/library/4772/dan-hill.pdf
https://www.youtube.com/watch?v=TZ60rMqdb0U

Greenness Health Impacts

One Street: Different Blocks- Different Health Outcomes

Higher greenness levels are associated with reductions of cardiometabolic conditions as well as heart disease, depression, and Alzheimer's Disease.

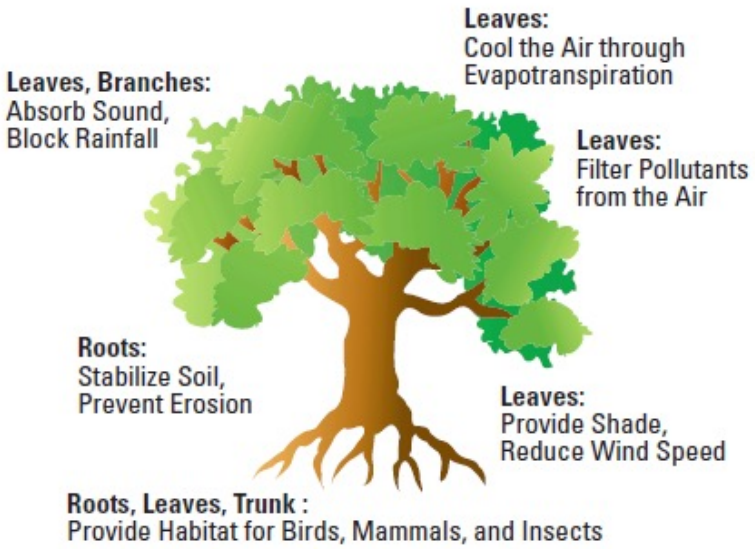
An increase in mean block-level NDVI from -1 SD to +1 SD above the mean was associated with reductions of:



U.S. Dept. of Housing & Urban Development (HUD) Sustainable Communities Research Grant # HUD H-21620-RG; and Health Foundation of South Florida Grant , PIs: S. Brown , E. Plater-Zyberk; Co-Is: J. Lombard, M. Byrne K. Wang,; J. Szapocznik, Scott Brown, Joanna Lombard, Kefeng Wang, Margaret Byrne, Matthew Toro, Elizabeth Plater-Zyberk, Daniel Feaster, Jack Kardys, Maria Nardi, Gianna Perez-Gomez, Hilda Pantin, José Szapocznik, "Neighborhood Greenness and Chronic Health Conditions in Medicare Beneficiaries," *American Journal of Preventive Medicine*, July 2016, Vol.51, Issue 1, 78–89.

"Relationship of neighborhood greenness to heart disease in 249,405 U.S. Medicare beneficiaries," K.Wang, J.Lombard, T.Rundek, C.Dong, C.M.Gutierrez, M.M.Byrne, M.Toro, M.Nardi, J.Kardys, J.Szapocznik, S.C.Brown, *Journal of the American Heart Association*. Vol.8(6), 19 Mar. 2019; "Health disparities in the relationship of neighborhood greenness to mental health outcomes in 249,405 U.S. Medicare beneficiaries." S.C.Brown, T.Perrino, J.Lombard, KWang, M.Toro, T.Rundek, C.M.Gutierrez, C.Dong, E.Plater-Zyberk, M.Nardi, J.Kardys, J. Szapocznik, *International Journal of Environmental Research & Public Health*, 15(3): 430, 2018.

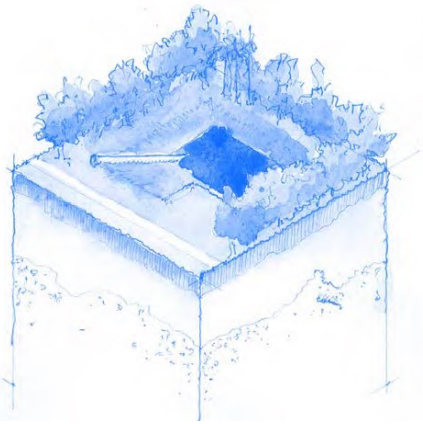
Adaptation for Climate & Health



Million Trees Miami
Miami-Dade County Parks
Recreation & Open Spaces

https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_2.pdf

Adaptation for Climate & Health



Stormwater Park, Department Design Office, Isaac Stein and Maggie Tsang, with Adler Guerrier and Andrew Aquart
Van Alen Institute, *Keeping Current* Program, 2020

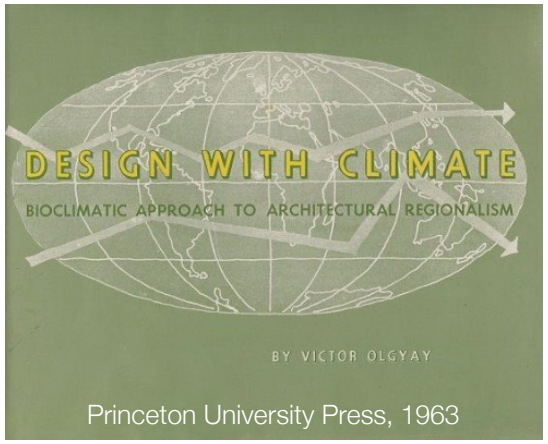
Adaptation for Climate & Health

Greening Public Space

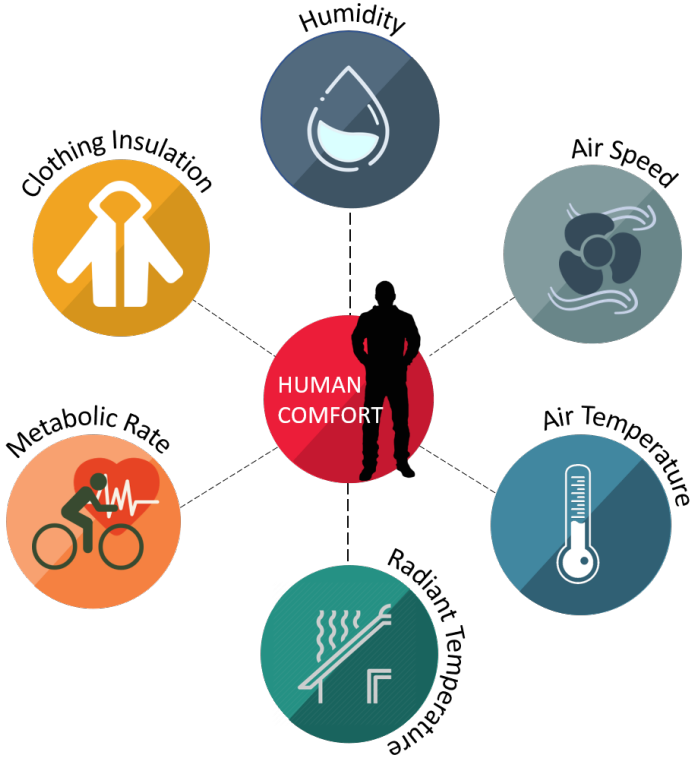
More than 30% of Miami-Dade County's developed land is dedicated to transportation, communication and utilities.

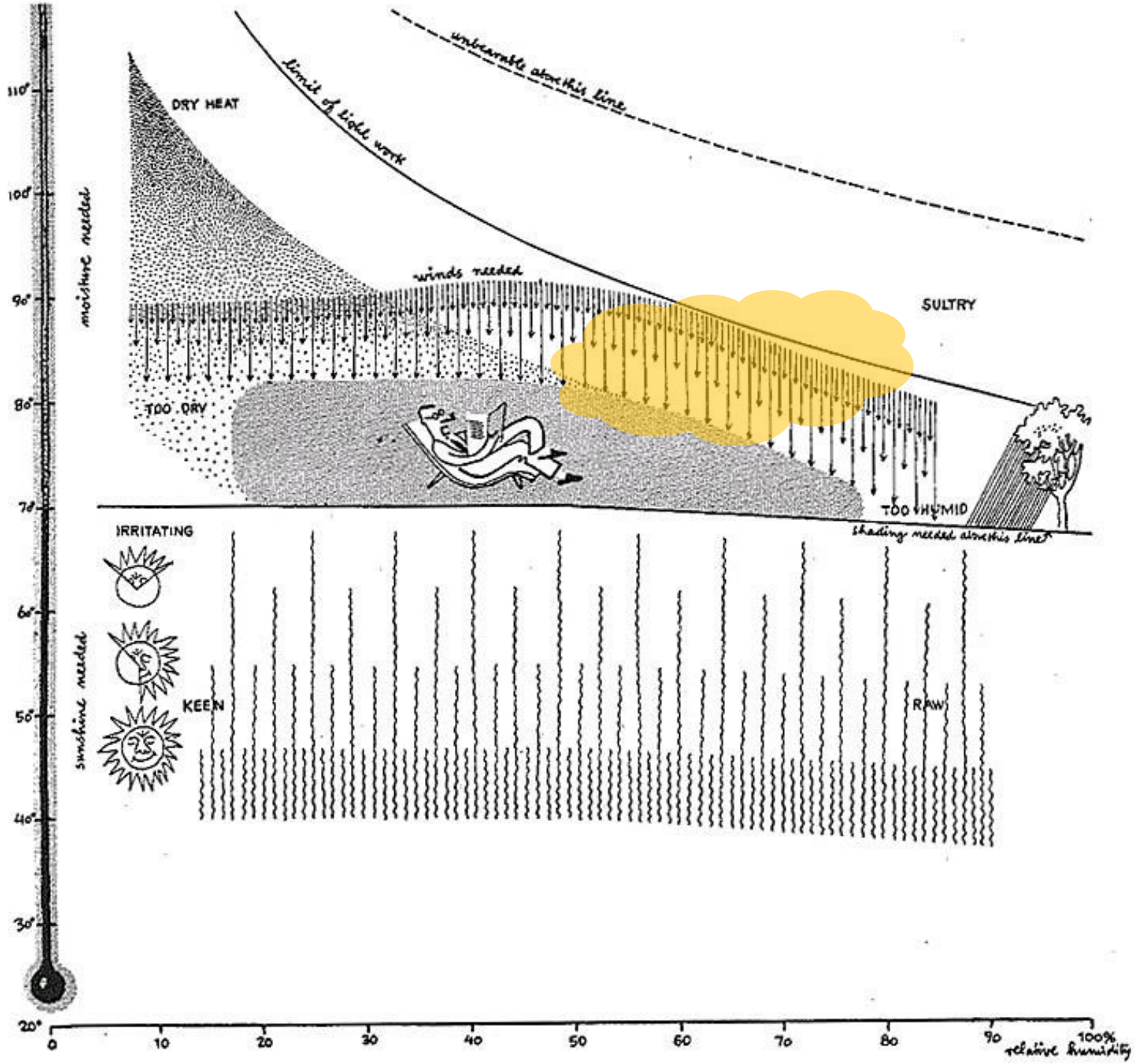
https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_2.pdf

Comfort



Princeton University Press, 1963



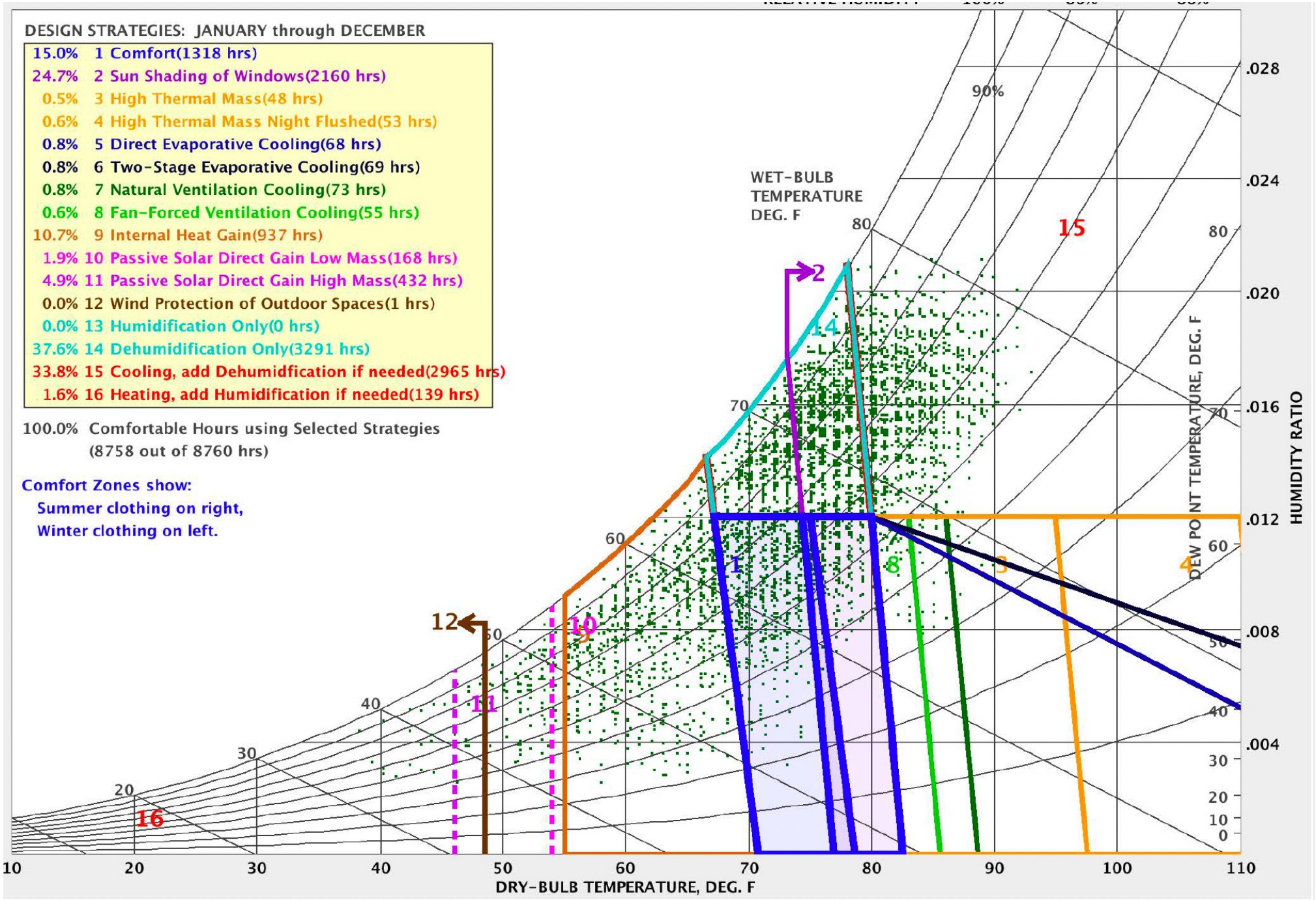


https://www.linkedin.com/pulse/role-cfd-evaluating-occupant-thermal-comfort-sandip-jadhav/

Comfort

Miami

Psychometric Chart, ASHRAE Standard 55-2004 using PMV, UCLA



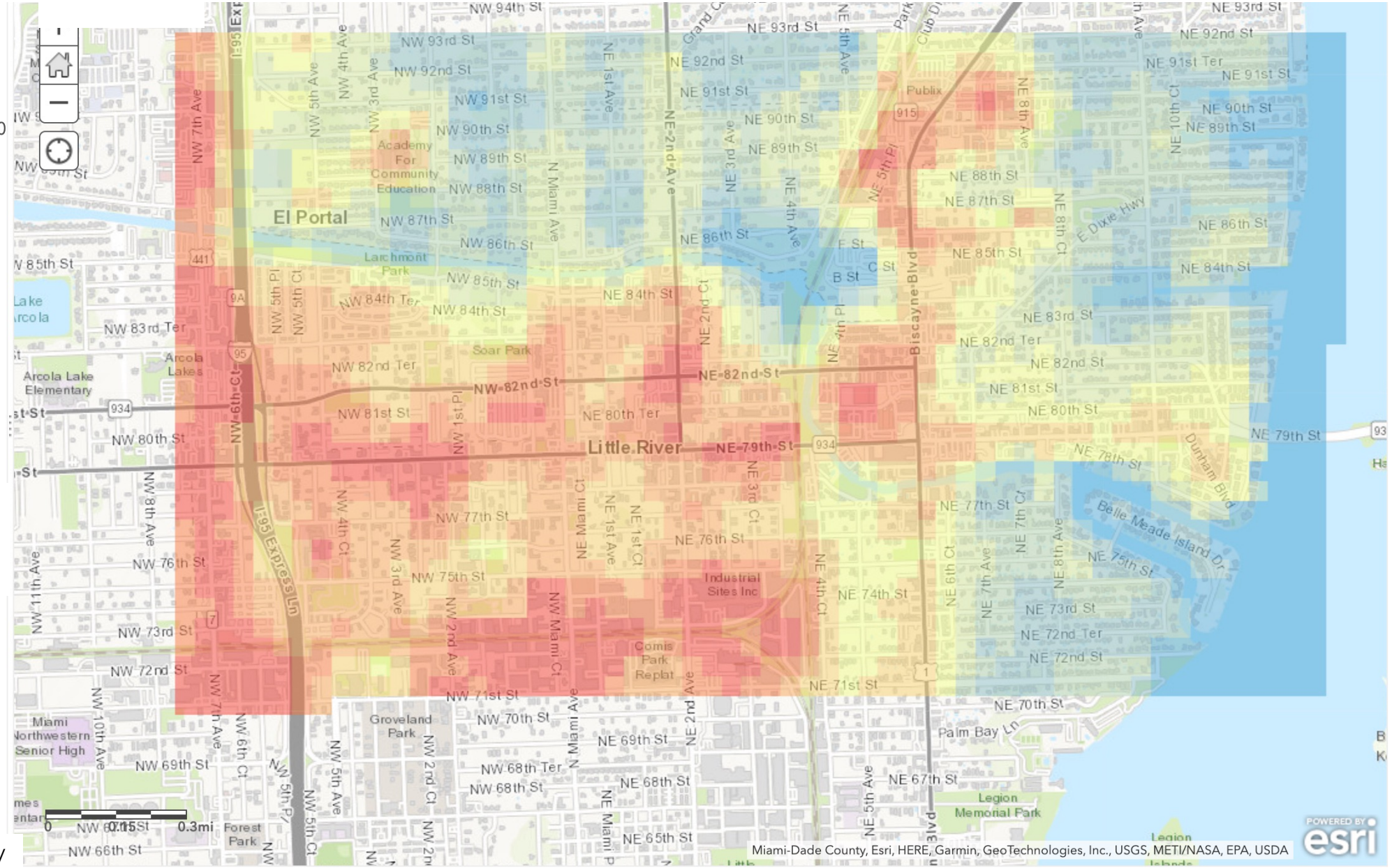
https://www.sbse.org/resources/climate-consultant

Hyperlocalism

Surface Heat Temperatures

LR_LandsatARD_20060813_20170830_20180801

- <= 109.24
- <= 110.95
- <= 112.51
- <= 115.48
- <= 118.13
- <= 120.63
- <= 122.65
- <= 124.84
- <= 134.51



Map by Abraham Parrish
UM U-LINK
HyLo Climate Team

https://www.hyloclimate.com/