

**国家自然科学基金委员会**  
National Natural Science Foundation of China



# Urban trees for climate change adaptation

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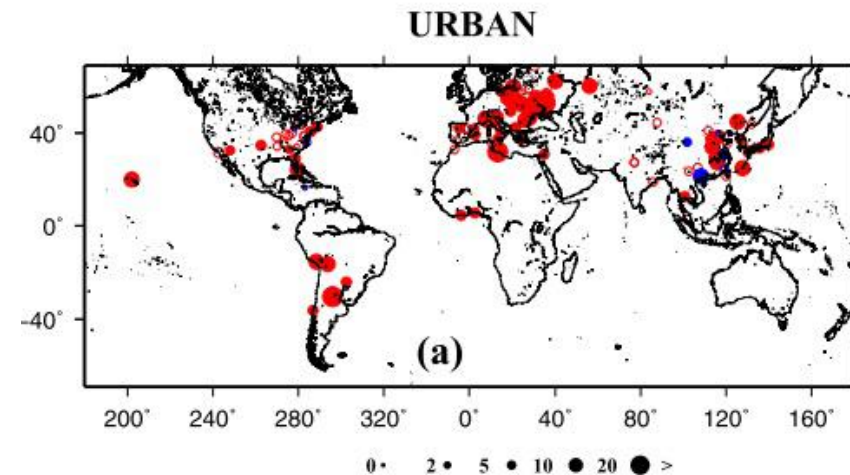
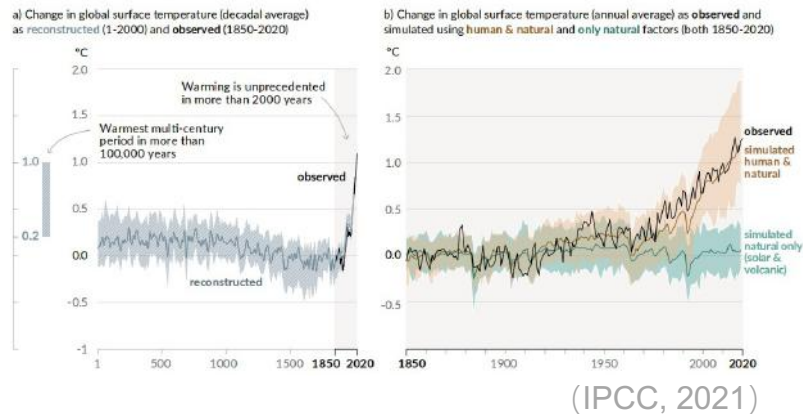
Research Center for Eco-Environmental Sciences

Chinese Academy of Sciences

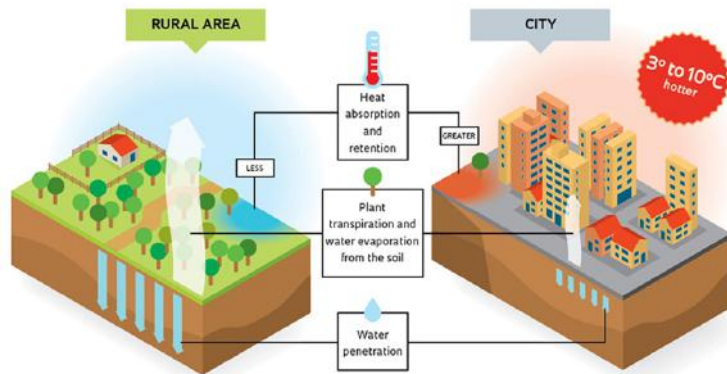
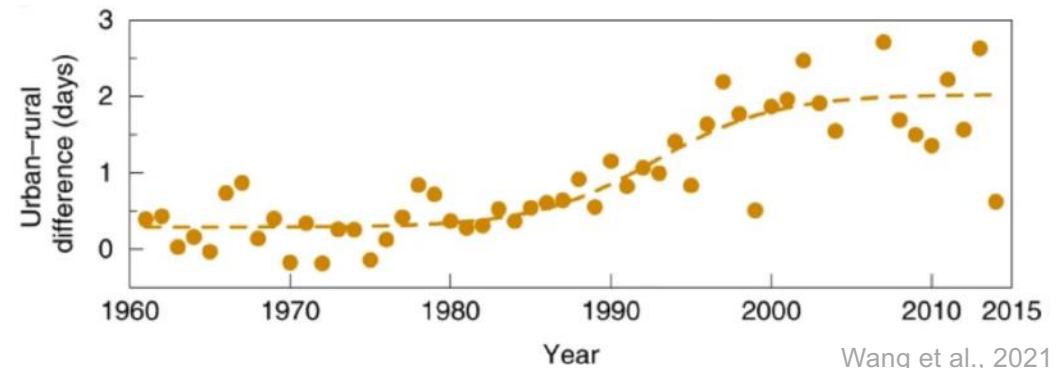
# Climate change: Cities face intensified warming

More frequent and intense hot extremes in cities: Synergistic interactions between climate change and urban heat island effects

Changes in global surface temperature relative to 1850-1900



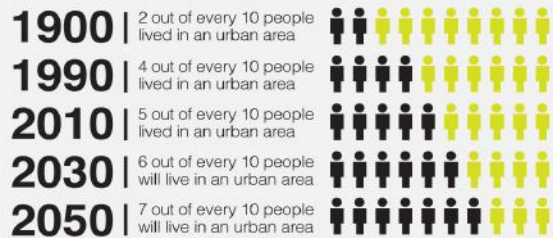
More extreme events in urban areas



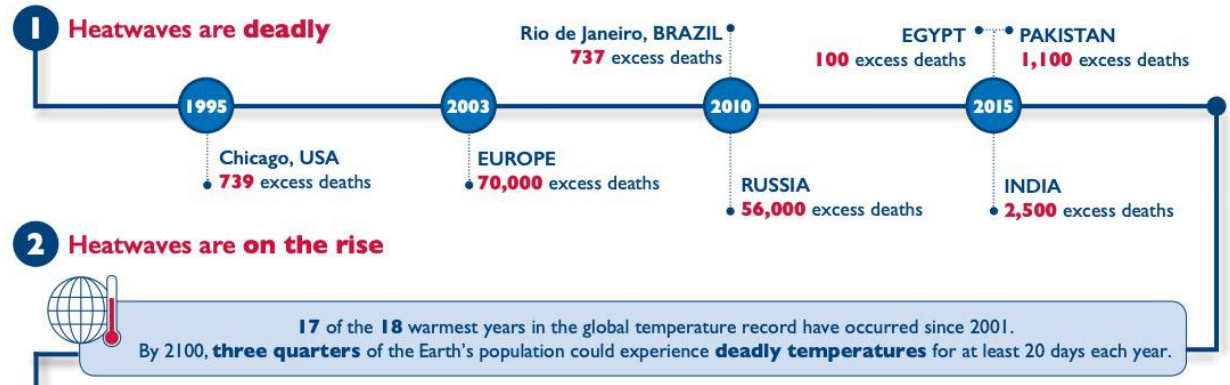
# Climate change: Cities are vulnerable and at risks

Climate change is an urgent threat to the quality of life in urban areas

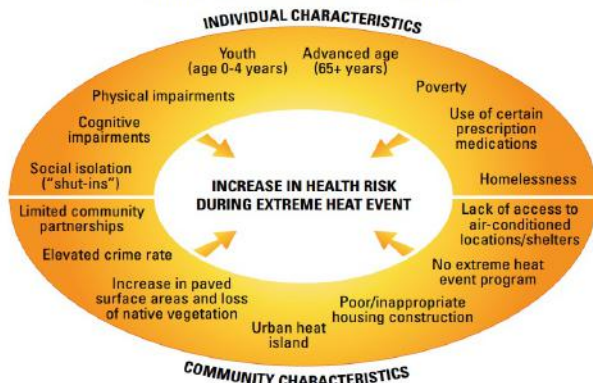
## Urbanization



Defined by UN HABITAT as a city with a population of more than 10 million

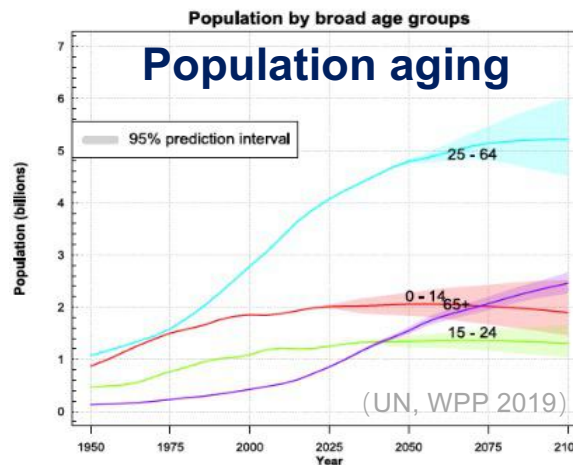


## CERTAIN CHARACTERISTICS INCREASE RISK FROM EXTREME TEMPERATURES



Certain personal and community characteristics increase the risk of experiencing health problems during an extreme heat event.<sup>4,9,10,11</sup>

(ATLAS project, 2020)



# Cities are leading the fight against climate change

## URBAN ACTION

Cities throughout the world are participating in the World Mayors Council on Climate Change and the C40 Cities Climate Leadership Group



“...a solution to societal challenges that is inspired or supported by nature, which is cost-effective, simultaneously provides environmental, social and economic benefits and helps build resilience. These solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.”

From: Department of Research and Innovation of the European Commission

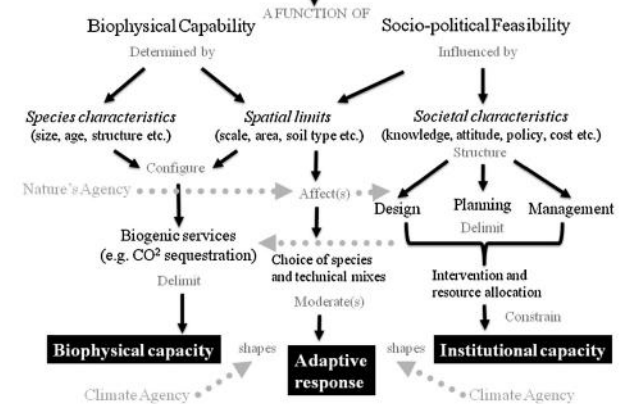
## Nature-based Solutions

Rosenzweig et al. 2010; Matthews et al. 2015; UNEP 2021



Hongkong: energy-efficient skyscrapers Paris: car-free (in the center, at least)

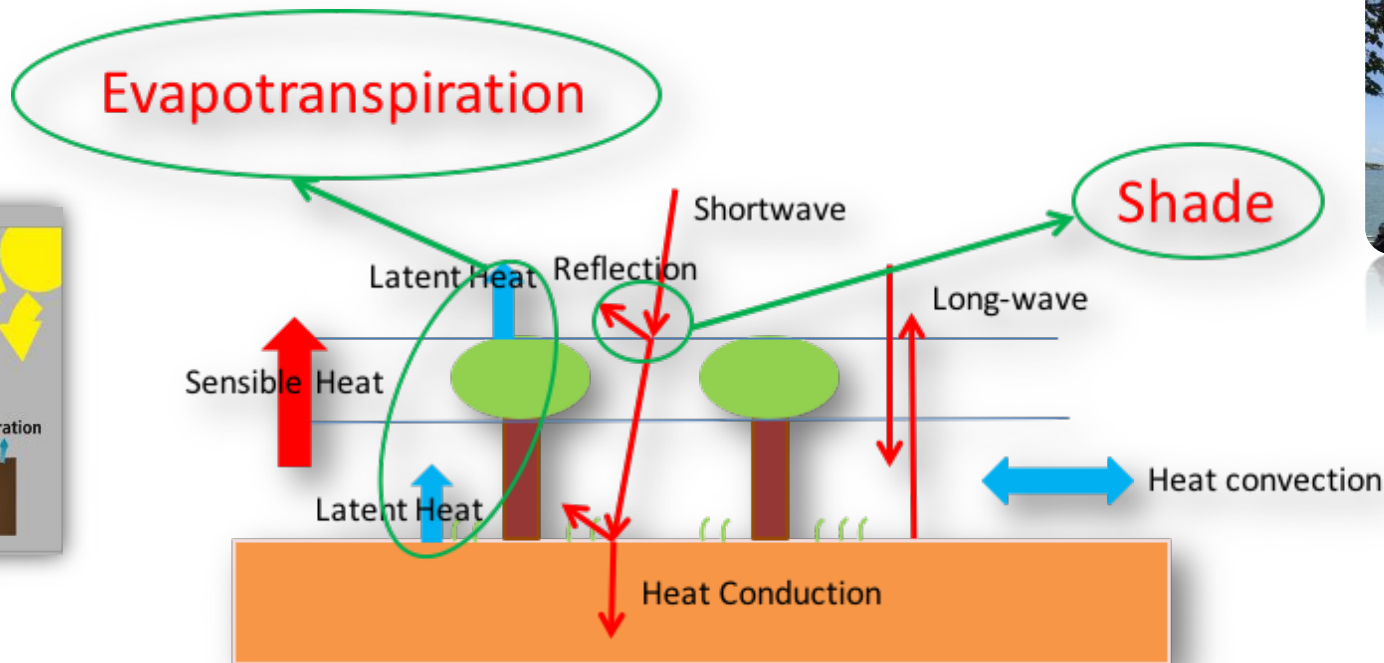
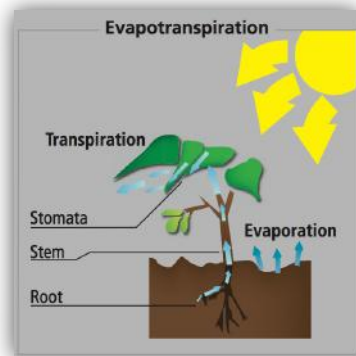
### Capacity of Green Infrastructure for Climate Adaptation



## Urban green infrastructure 4

# Cities use trees to adapt to climate change

**Urban trees:** constitute one of the most proposed nature-based mitigation tools in cities around the world, regardless of the climate context.



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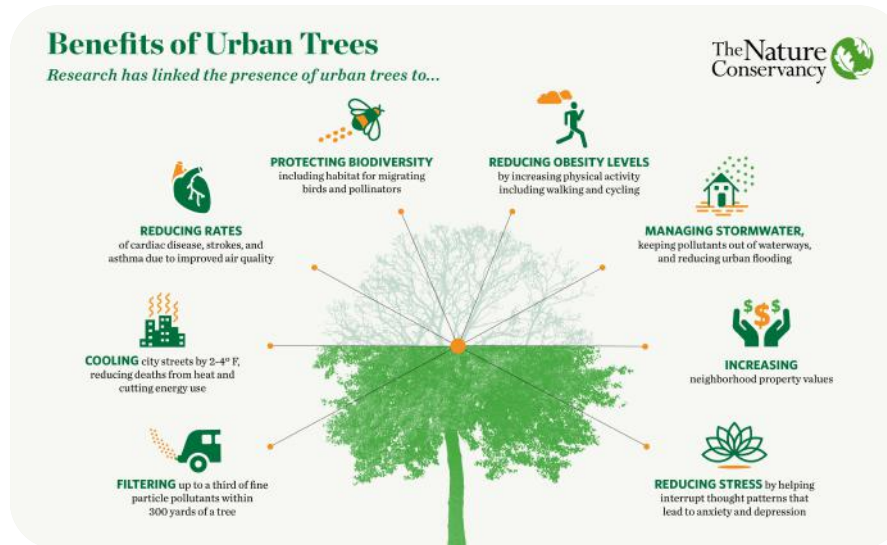


TreeBaltimore



5 Million Tree Campaign

More than cooling: trees bring many benefits



Beijing: Million Mu Trees

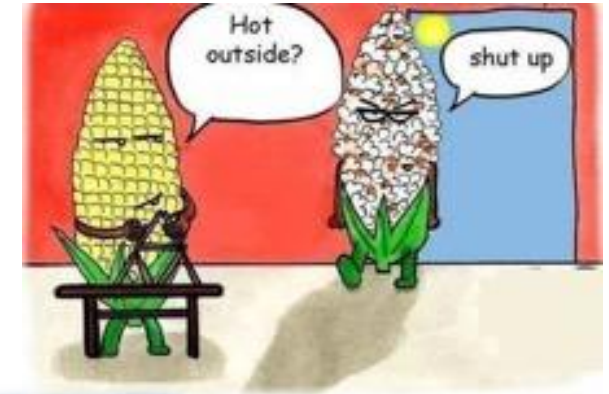


# Cities use trees to adapt to climate change

## Grand challenges

- Heat disproportionately affects different urban populations, with the urban poor and people of color being more exposed and having limited capacity to mitigate heat or adapt to extreme heat events.

Affects people differently



Pictures from the internet

- Cities have limited space and resources for greening.

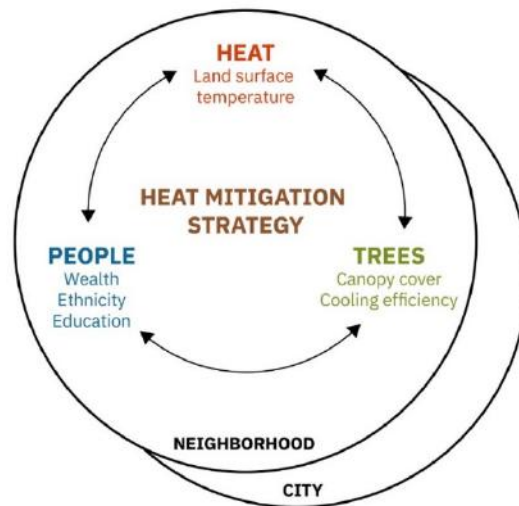
# The Key Question & Hypotheses

**In what physical and social conditions does the cooling capacity of trees have the greatest environmental and social impact?**

- Increasing the urban tree canopy (UTC) will have a greater cooling effect in hotter neighborhoods that have fewer trees.
- The presence of socially vulnerable populations predicts locations in which trees will have greater cooling effects.



31.5°C



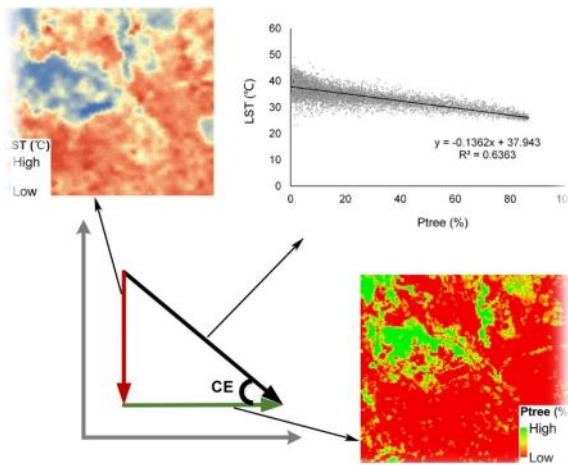
Zhou et al., *One Earth*, Under revision



36.0°C



# Test the Hypotheses



**Cooling efficiency (CE):** magnitude of temperature reduction associated with one percent (1%) increase of UTC cover

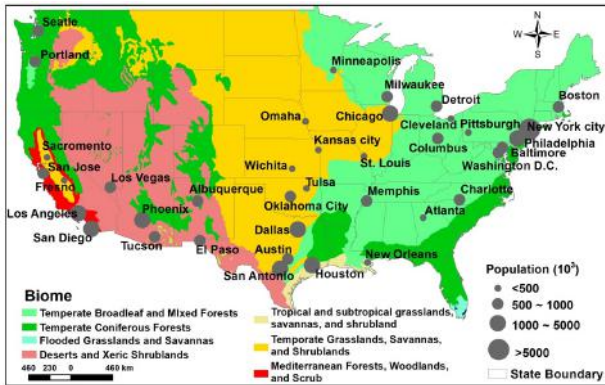


Planting in the **right locations** to maximize the cooling benefits of urban trees, socially and ecologically, using **cooling efficiency as a metric**

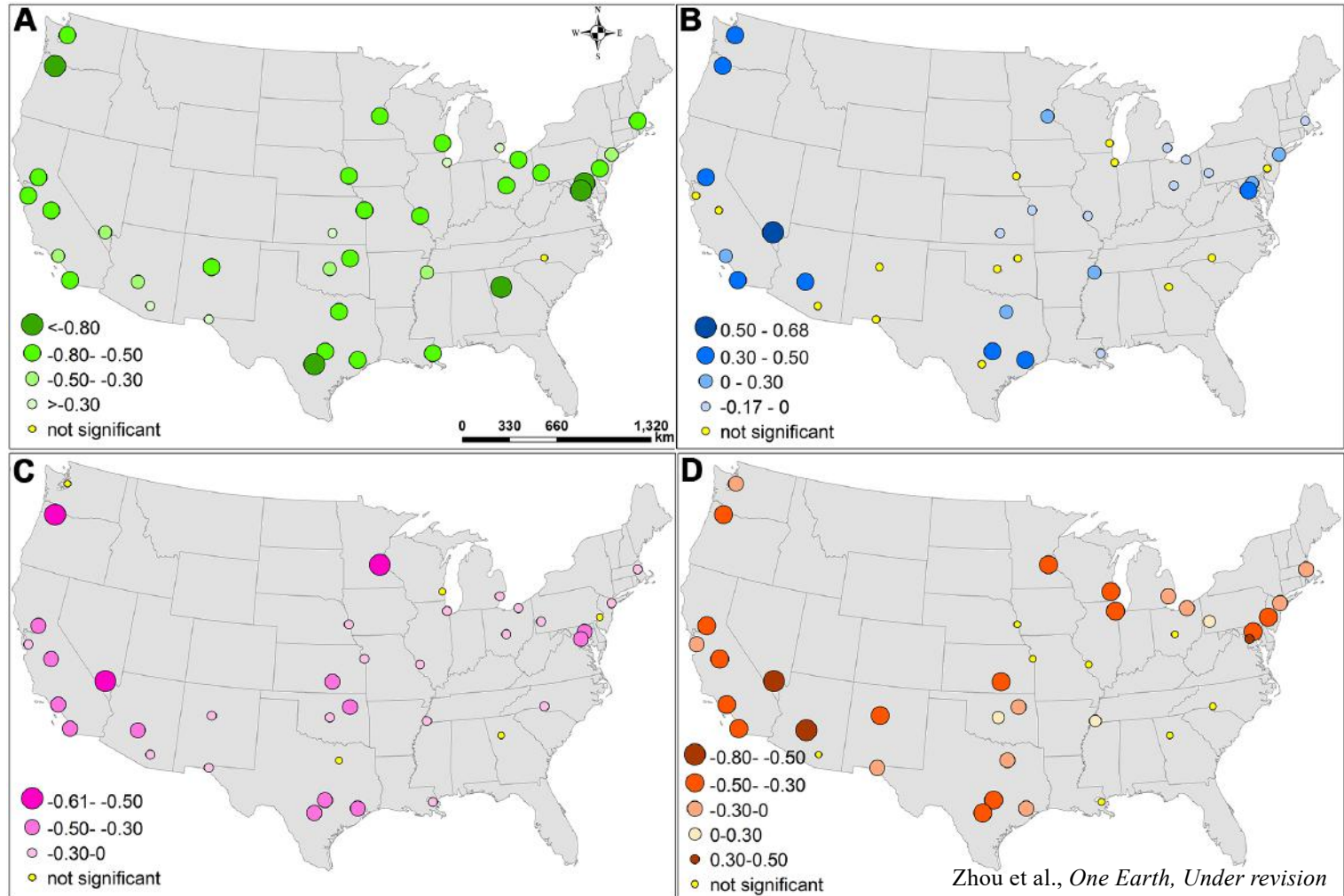


- Does the cooling efficiency (CE) of urban tree canopy (UTC) vary across space among different cities and within a city?
- How to maximize cooling benefits from a social-ecological perspective?

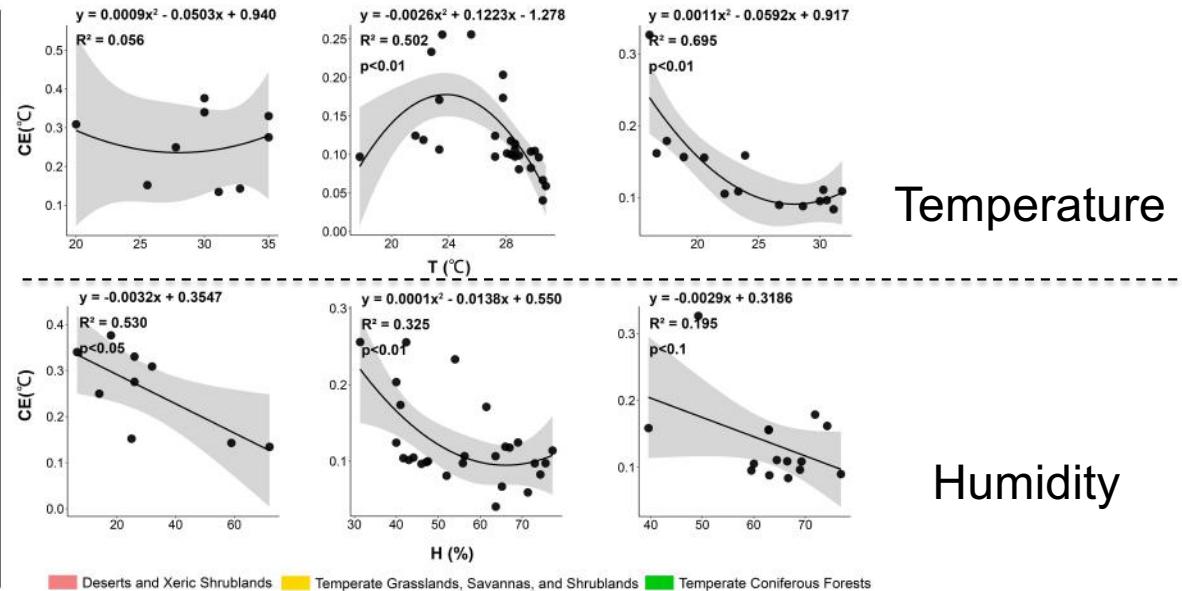
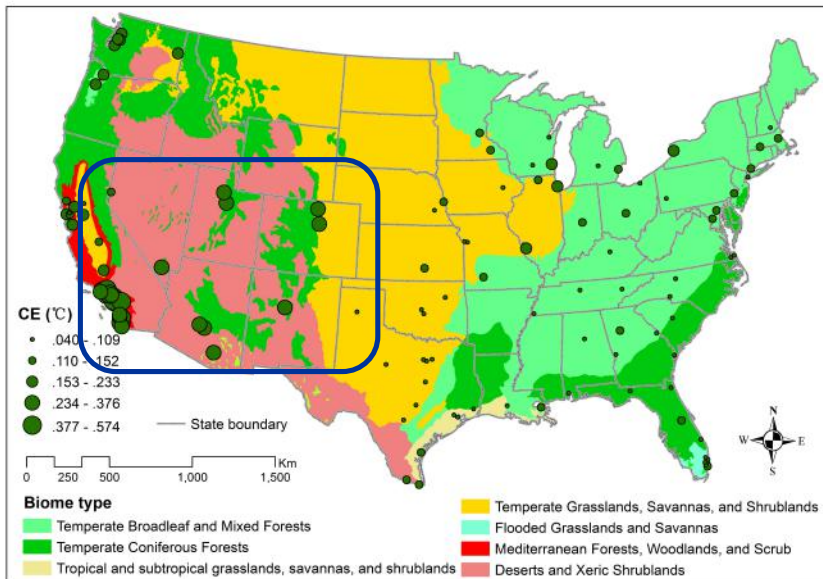
# Income, race, education, and urban heat



- Urban populations with more people of color, lower income, and less education tend to live in hotter neighborhoods that have less tree canopy cover.
- Consistent across the 38 largest American cities at a national scale.



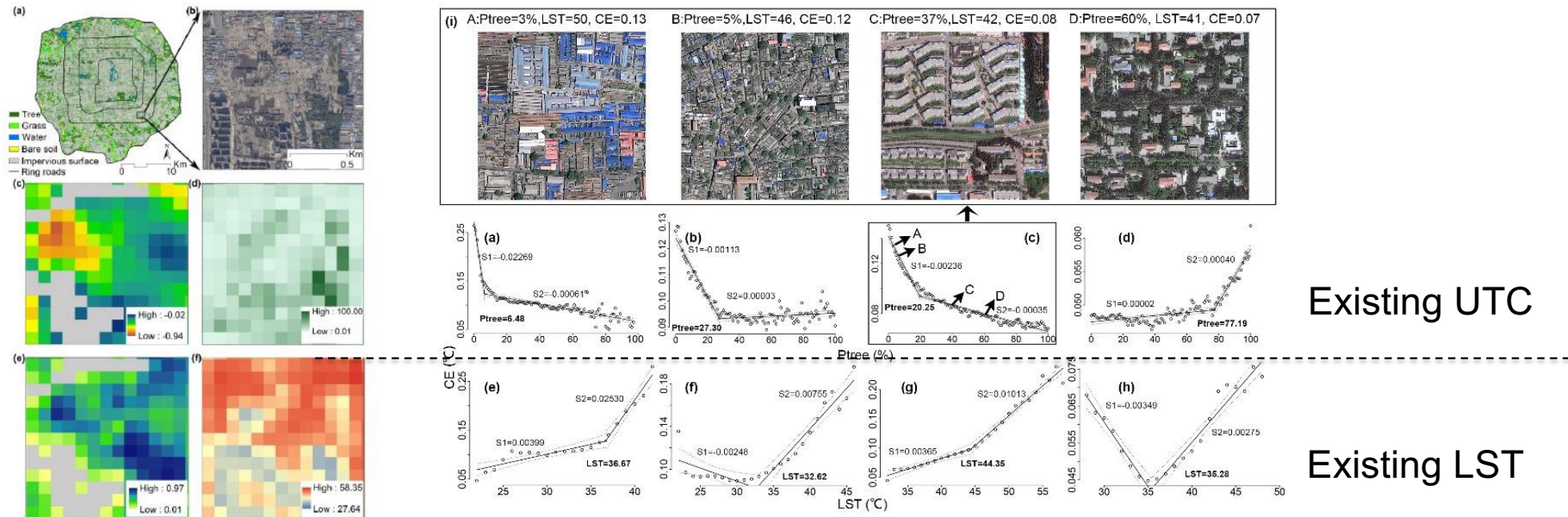
# Urban trees's CE varies greatly among cities



Wang & Zhou\*, *ISPRS-J. Photogramm. Remote Sens.*, 2020

- CE was higher in southwestern cities especially in hot and dry biomes.
- Climatic context including air temperature, humidity and wind speed strongly affected CE in a non-linear way with threshold which can have important implications.
- Extremely high air temperature would result in decrease of CE in most cities.

# Urban trees's CE varies greatly within a city

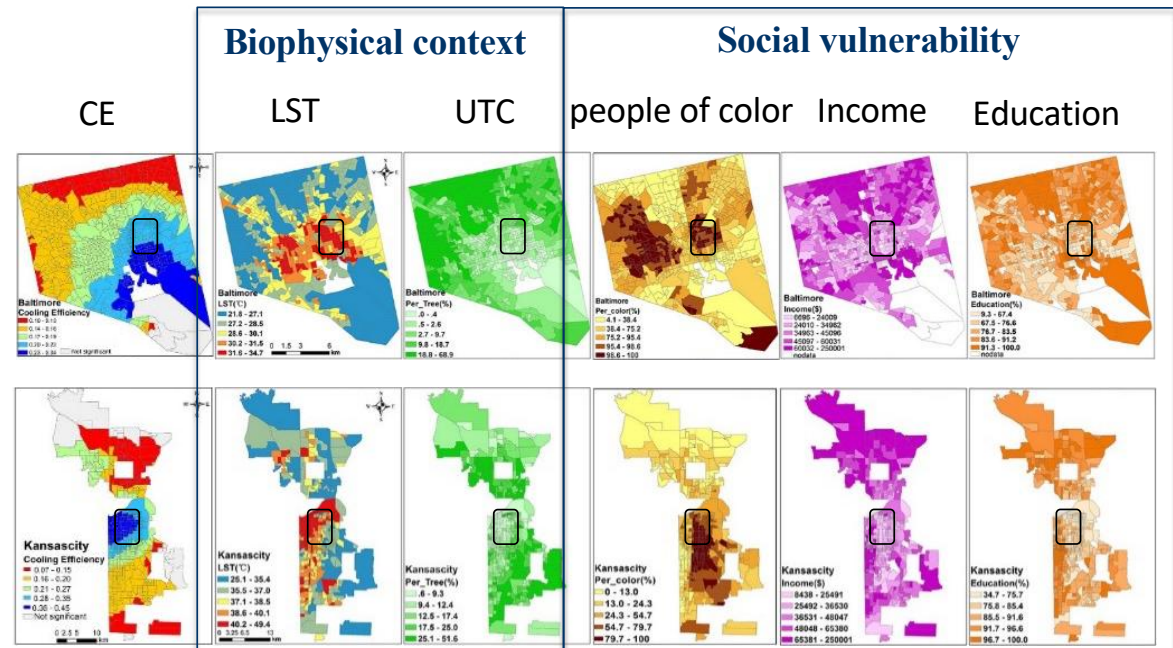
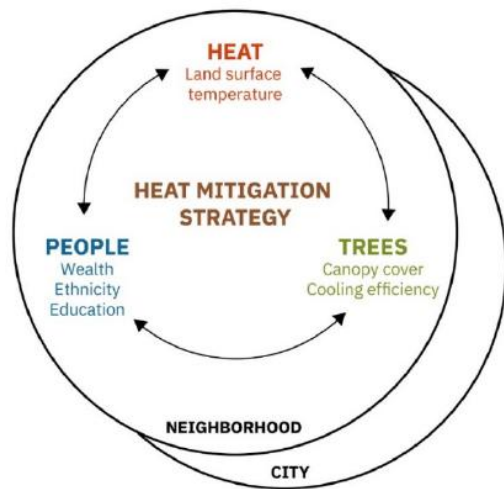


Wang & Zhou\*, *Front. Ecol. Environ.*, 2021

- CE varied greatly in space within a city, **greater in locations with fewer UTC, and higher LST.**
- CE first decreased sharply with the increase of UTC, and then the decreasing rate slowed down or became relatively stable after Ptree reaching **a certain threshold** which can help identify and prioritize locations for tree planting to achieve better cooling.

# Urban trees have greater cooling effects in socially vulnerable communities

- Tree planting in **hotter, more socially vulnerable neighborhoods** achieved greater cooling benefits.
- Increasing tree cover in these neighborhoods will meet the **greatest need for cooling, and achieve greater cooling capacity, creating social and ecological win-wins.**



Social-ecological win-wins needs comprehensive understanding that relates excessive urban heat, people, and urban trees

If the world's 1 million municipalities were nature-positive, we could tackle climate change



The botanical gardens in Curitiba, Brazil, a leader in green city design. Image: Wikicommons

Together, we can tackle climate change

Look forward to cross-city comparison studies

Thank you & Questions

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