Collaborating / End-User Organization - City of Phoenix

SOCIOECONOMIC DISPARITIES AND ASSOCIATED SOCIAL INEQUITY IN CONNECTION TO URBAN HEAT STRESS

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PHX WATER SMART

Research Objective

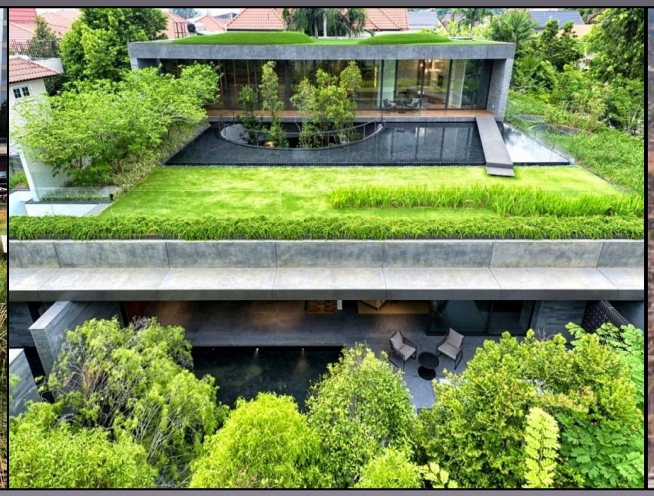
The goal of this study is to evaluate the environmental inequality of heat exposure among different socioeconomic status groups.

This study investigates the relationship ECOSTRESS LST layers and socioeconomic as well as demographic factors to understand LST patterns, the distribution of heat exposure, and the association with the parameters.

This enables us to understand and quantify urban heat island (UHI) and its contributing factors and associated social inequity status to achieve urban sustainability and improve the quality of life in Phoenix.

Different Urban Settings

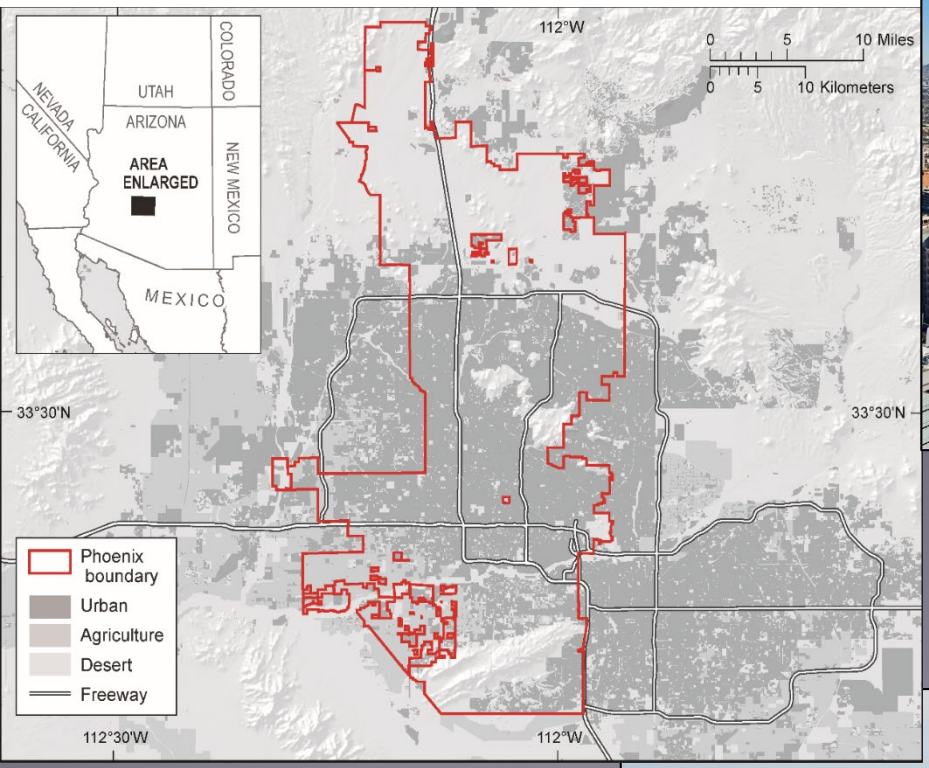
Portland, OR



Singapore

Phoenix, AZ

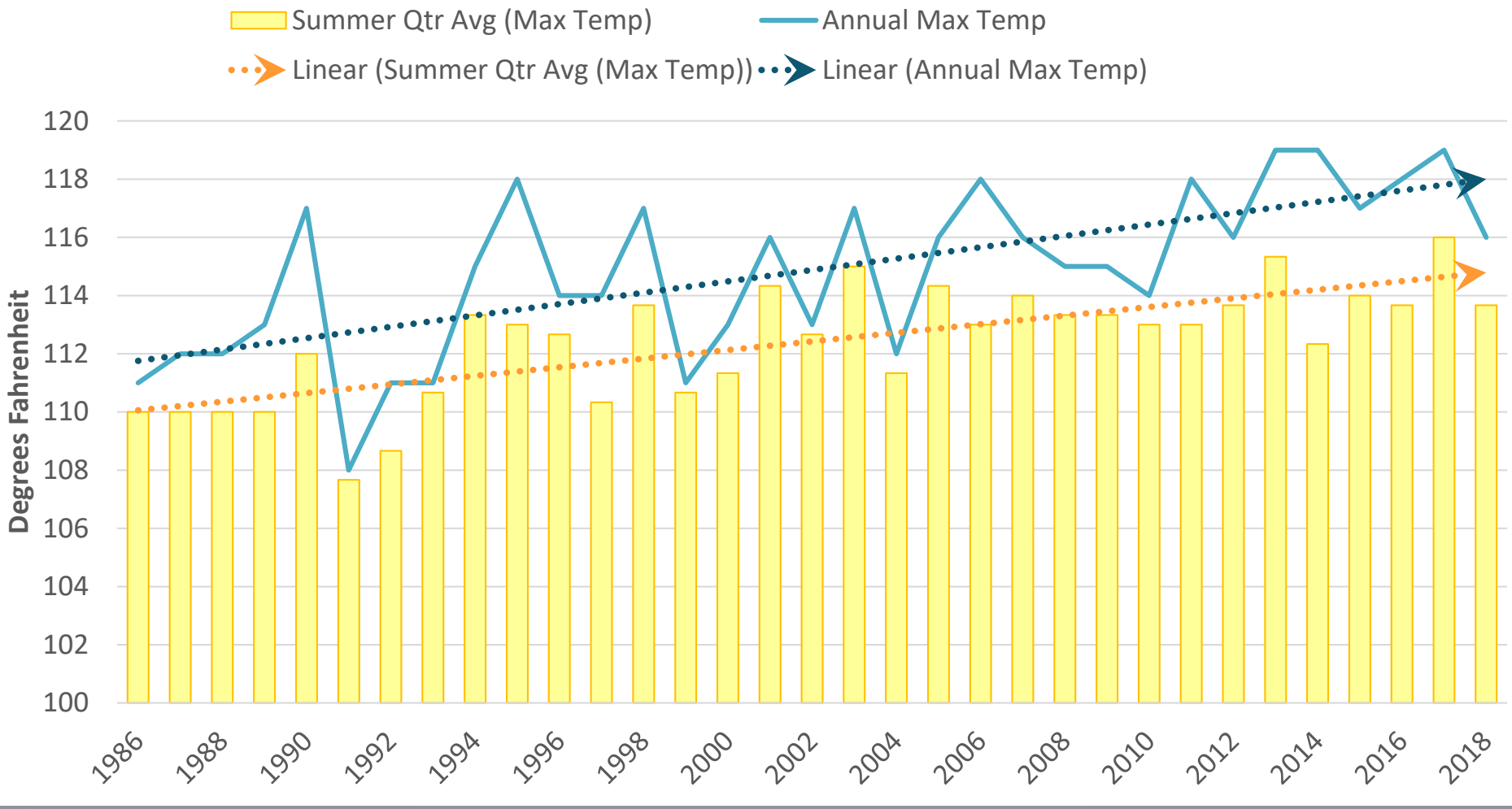
Study Area (City of Phoenix)



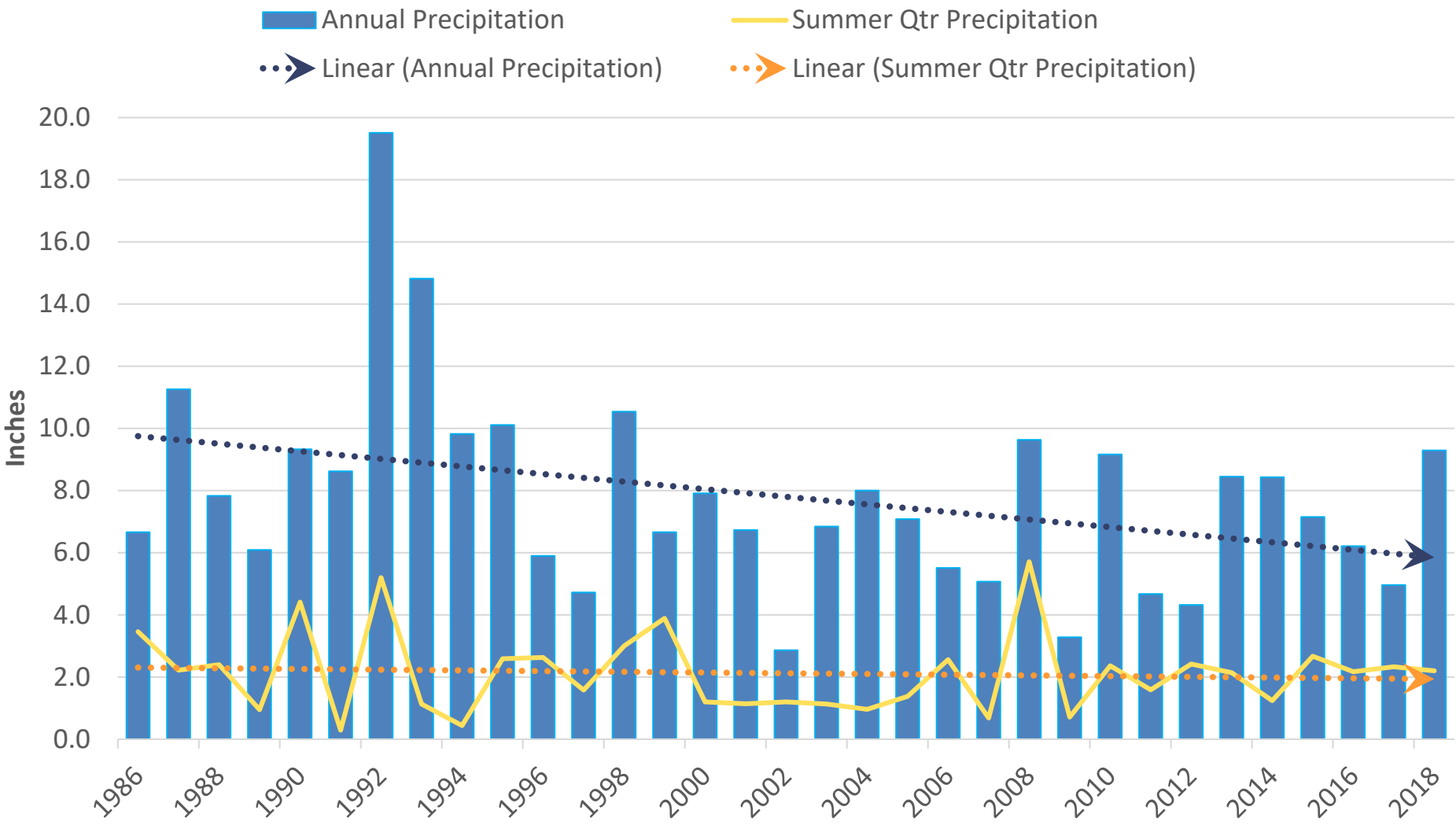
Background: Phoenix

- Phoenix has a unique climate compared to most of the U.S.
  - Phoenix is the sixth most populous city in the United States
  - An estimated population of approximately 1.68 million (2019) within a 1941 km^2 area
  - Phoenix has a subtropical desert climate with mild winters and scorching summers; daily maximum temperatures exceed 38°C (~100.4°F) throughout summer
  - Phoenix is the hottest city in the United States.
  - does not have large areas of turf and tree canopy
  - year round landscape watering and pool makeup water
  - difficult to fit to previous models

Temperature Trends



Precipitation Trends



Data and Analysis

- Socioeconomic and demographic variables, including the percentage of each race/ethnicity, and diversity index at the block group level, were converted to 70-m grids to match the resolution and projection of the LST data.

- The relationships between socioeconomic and demographic variables and ECOSTRESS LST only in the urban core were observed.

Regression analysis between LST and socio-economic parameters

We explored the relationship between the socio-economic indicators including

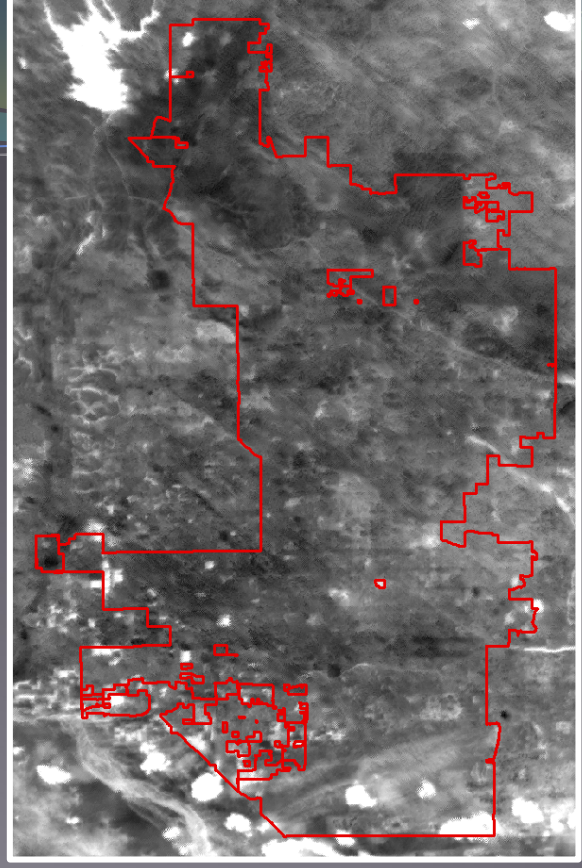
(1) house property values (HPV)
(2) median household income (MHI), and
(3) percentage of household below poverty level (POHBPL) and

land surface temperatures (LST) in
(1) summer daytime and (2) winter daytime in the Urban Core.

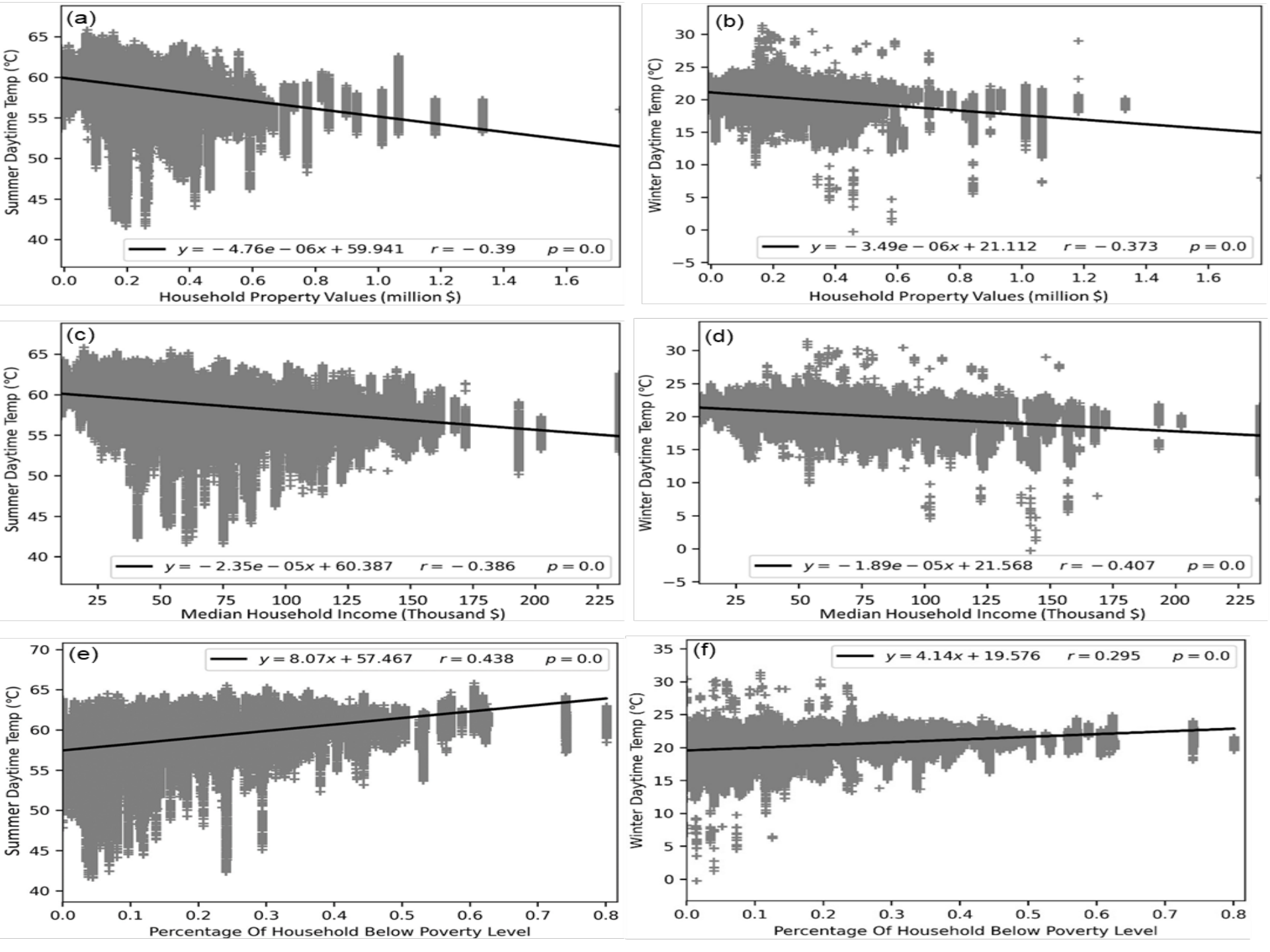
Regression analysis between LST and race/ethnicity

Category	Race/Ethnicity	Abbreviation
Race	White alone	WH
	Black or African American alone	BL
	American Indian and Alaska Native alone	AA
	Asian alone	AS
	Native Hawaiian and Other Pacific Islander alone	HP
	Two or more races	TR
Ethnicity	Hispanic or Latino	HI
	Non-Hispanic	NH

ECOSTRESS LST



Sensor	Date	Time
ECOSTRESS LST (ECO2LSTE v001)	2019-08-02, 2019-08-05, 2019-08-25	Summer daytime
	2019-06-30, 2019-07-11, 2019-08-28	Summer nighttime
	2019-02-24, 2019-02-28, 2019-12-27	Winter daytime
	2019-01-29, 2019-01-04, 2019-01-08	Winter nighttime


(a)
Summer Daytime Temp (°C)
y = −4.76e−06x + 59.941 r = −0.39 p = 0.0
Household Property Values (million $)
(b)
Winter Daytime Temp (°C)
y = −3.49e−06x + 21.112 r = −0.373 p = 0.0
Household Property Values (million $)
(c)
Summer Daytime Temp (°C)
y = −2.35e−05x + 60.387 r = −0.386 p = 0.0
Median Household Income (Thousand $)
(d)
Winter Daytime Temp (°C)
y = −1.89e−05x + 21.568 r = −0.407 p = 0.0
Median Household Income (Thousand $)
(e)
Summer Daytime Temp (°C)
y = 8.07x + 57.467 r = 0.438 p = 0.0
Percentage Of Household Below Poverty Level
(f)
Winter Daytime Temp (°C)
y = 4.14x + 19.576 r = 0.295 p = 0.0
Percentage Of Household Below Poverty Level

Statistics of socio-economic data during summer daytime

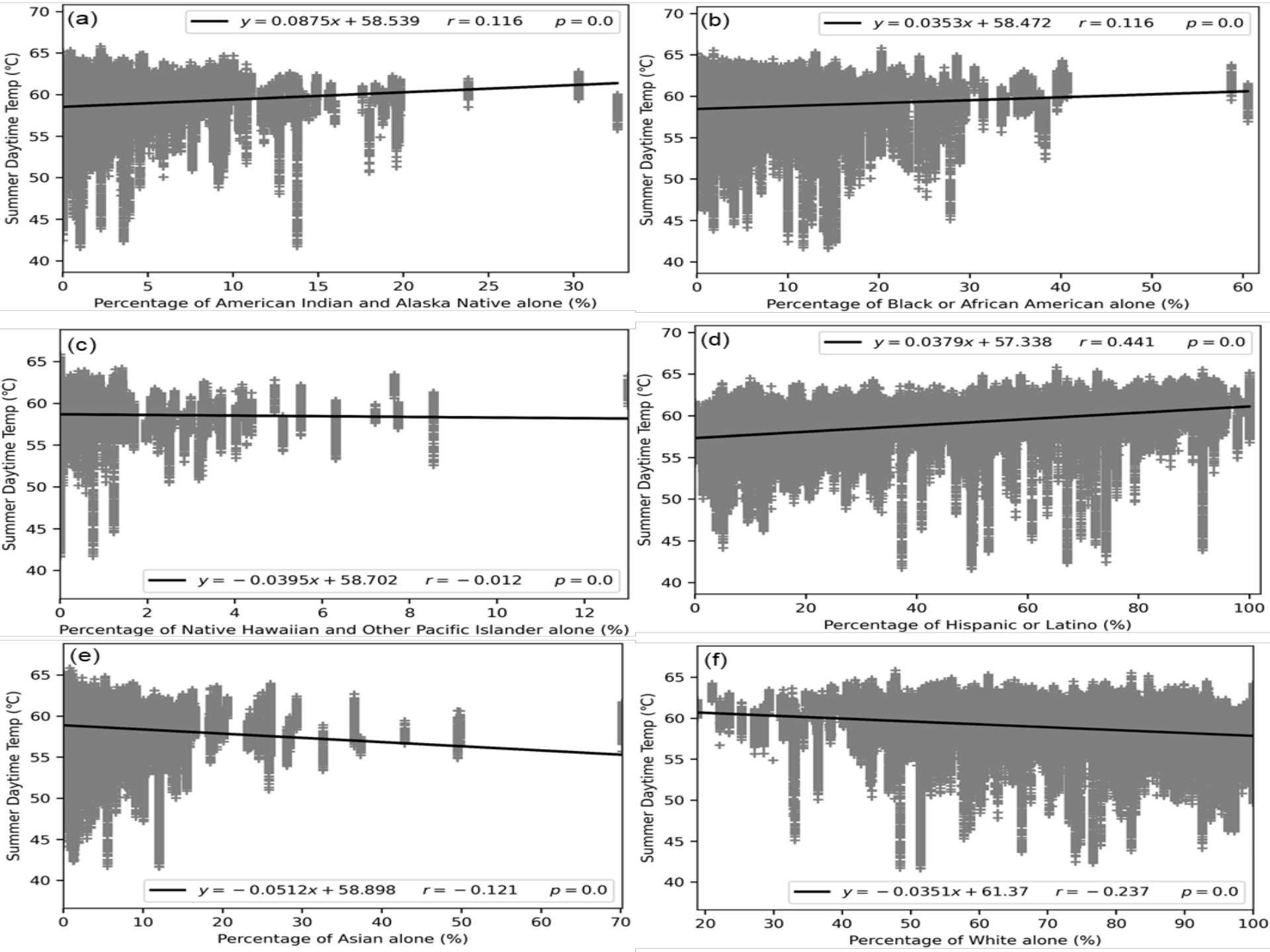
LST	HPV (Thousand $)	MHI (Thousand $)	POHBPL	NOP	POP	POA
Lowest	319.28	81.21	8.43%	22105	1.36%	2.21%
Lower	450.92	104.89	6.60%	89844	5.51%	7.57%
Low	352.15	88.80	9.33%	313874	19.25%	23.37%
High	226.34	64.06	16.60%	590706	36.23%	36.04%
Higher	159.70	48.44	26.28%	302451	18.55%	15.05%
Highest	158.99	48.26	26.42%	311460	19.10%	15.75%

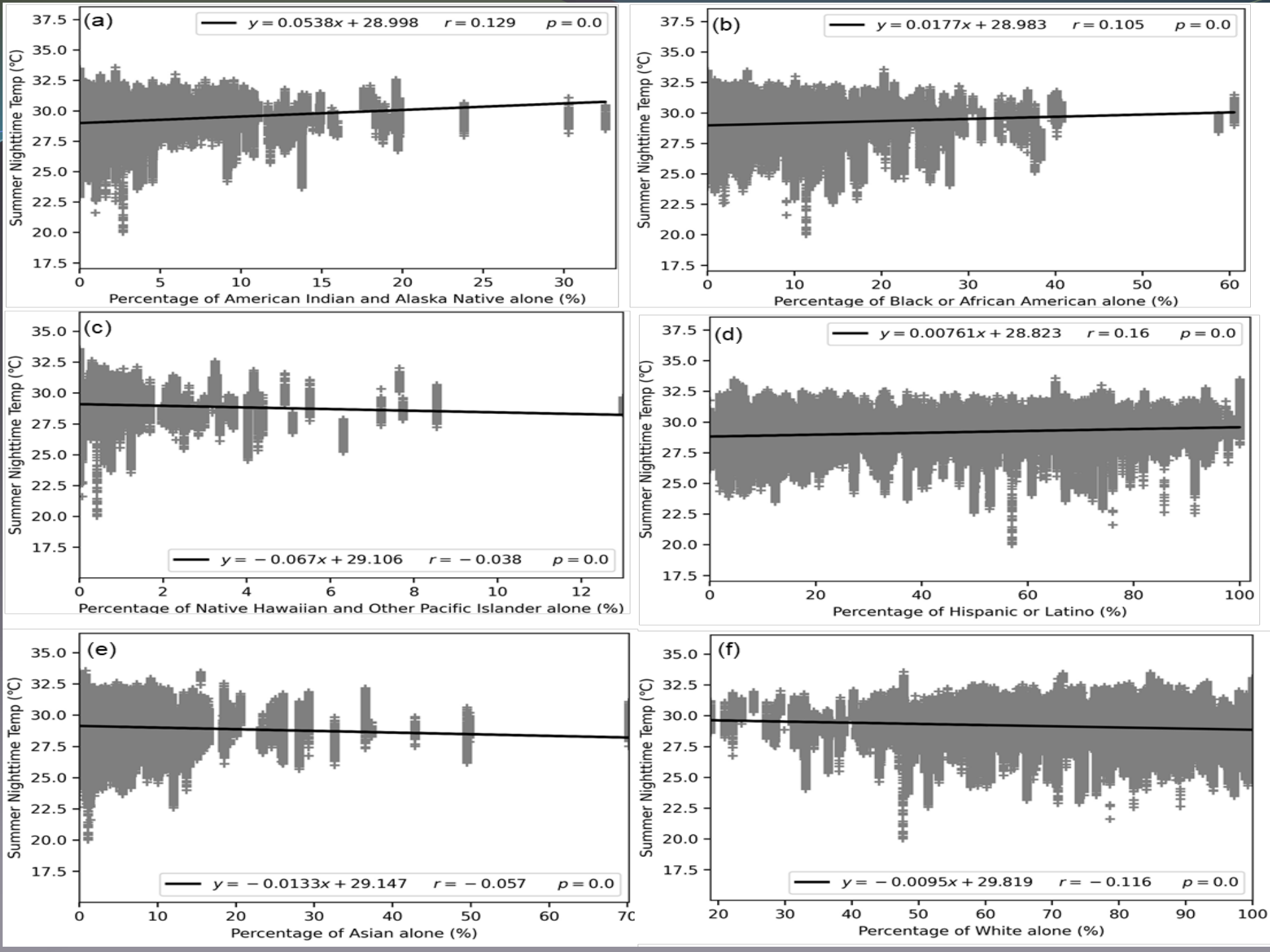
HPV: Household property values; MHI: Median household income; POHBPL: Percentage of household below poverty level; NOP: Number of populations; POP: Percentage of population; POA: Percentage of area

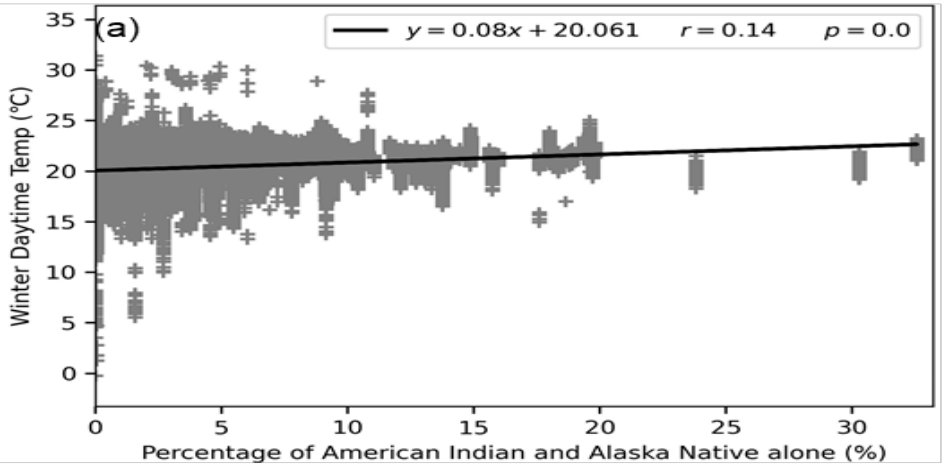
Statistics of socio-economic data during winter daytime

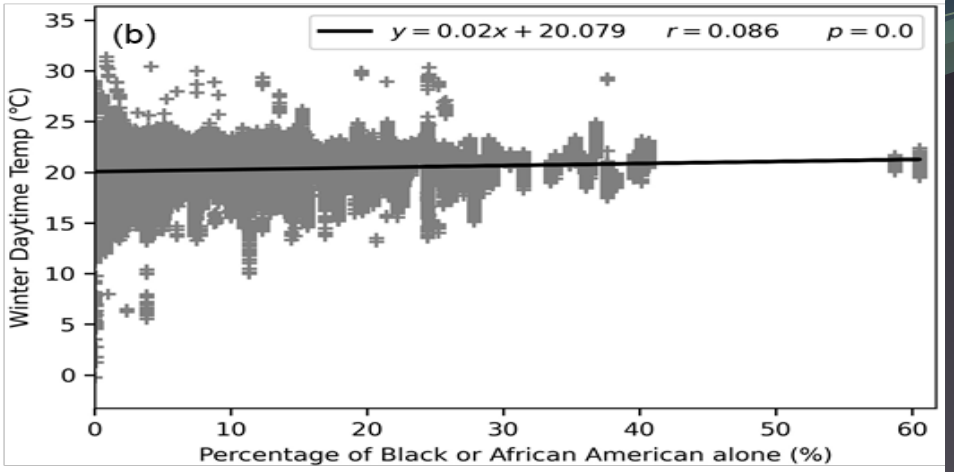
LST	HPV (Thousand $)	MHI (Thousand $)	POHBPL	NOP	POP	POA
Lowest	483.97	119.15	6.30%	24109.8	1.57%	4.44%
Lower	359.50	93.86	8.43%	64945.5	4.22%	8.06%
Low	311.45	80.41	12.57%	306568	19.91%	26.65%
High	230.20	62.10	18.23%	715397	46.45%	40.44%
Higher	172.82	53.37	19.51%	212193	13.78%	10.04%
Highest	174.57	53.76	19.24%	216905	14.08%	10.37%

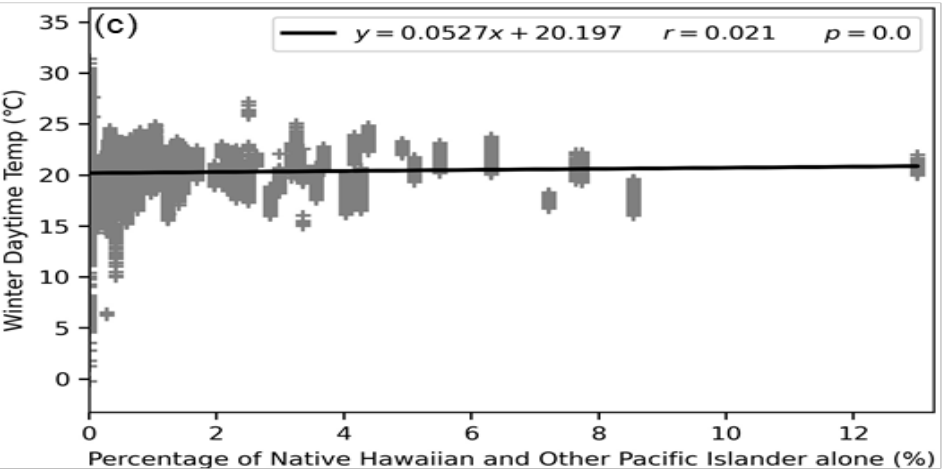
HPV: Household property values; MHI: Median household income; POHBPL: Percentage of household below poverty level; NOP: Number of populations; POP: Percentage of population; POA: Percentage of area

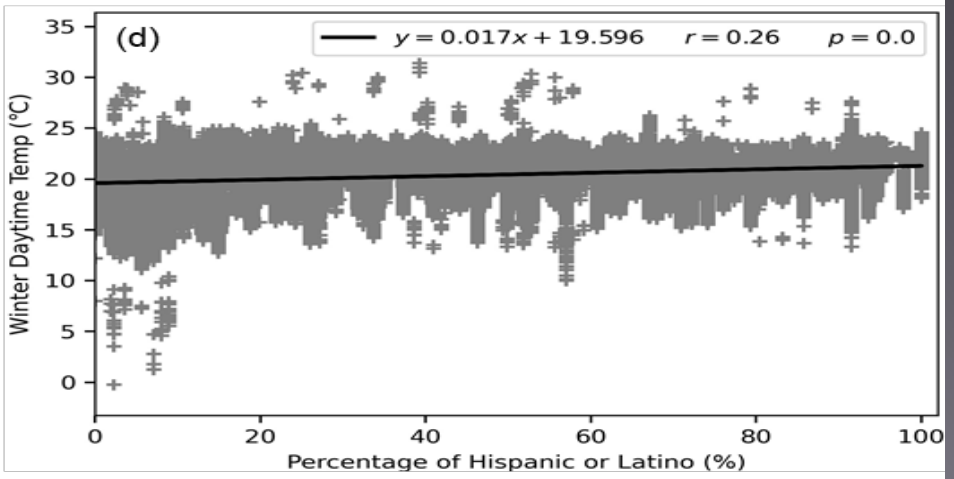

(a)
y = 0.0875x + 58.539 r = 0.116 p = 0.0
Summer Daytime Temp (°C)
Percentage of American Indian and Alaska Native alone (%)
(b)
y = 0.0353x + 58.472 r = 0.116 p = 0.0
Summer Daytime Temp (°C)
Percentage of Black or African American alone (%)
(c)
y = −0.0395x + 58.702 r = −0.012 p = 0.0
Summer Daytime Temp (°C)
Percentage of Native Hawaiian and Other Pacific Islander alone (%)
(d)
y = 0.0379x + 57.338 r = 0.441 p = 0.0
Summer Daytime Temp (°C)
Percentage of Hispanic or Latino (%)
(e)
y = −0.0512x + 58.898 r = −0.121 p = 0.0
Summer Daytime Temp (°C)
Percentage of Asian alone (%)
(f)
y = −0.0351x + 61.37 r = −0.237 p = 0.0
Summer Daytime Temp (°C)
Percentage of White alone (%)

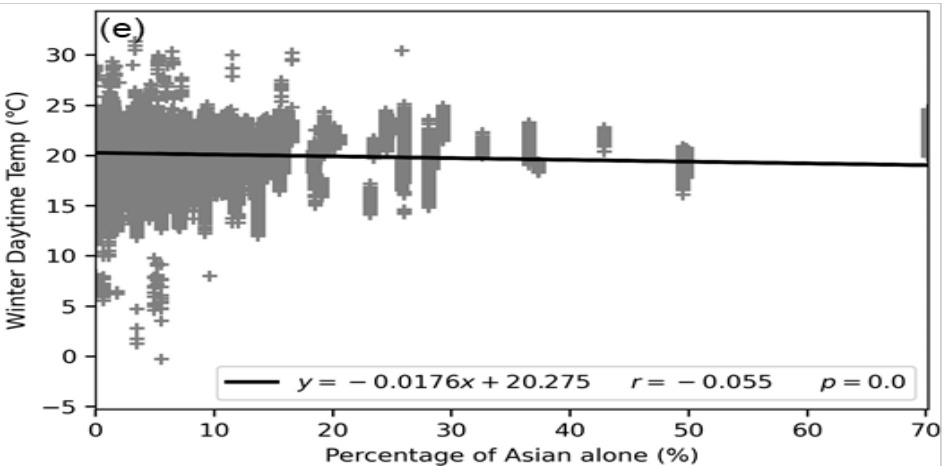

(a)
y = 0.0538x + 28.998 r = 0.129 p = 0.0
Summer Nighttime Temp (°C)
Percentage of American Indian and Alaska Native alone (%)
(b)
y = 0.0177x + 28.983 r = 0.105 p = 0.0
Summer Nighttime Temp (°C)
Percentage of Black or African American alone (%)
(c)
y = −0.067x + 29.106 r = −0.038 p = 0.0
Summer Nighttime Temp (°C)
Percentage of Native Hawaiian and Other Pacific Islander alone (%)
(d)
y = 0.00761x + 28.823 r = 0.16 p = 0.0
Summer Nighttime Temp (°C)
Percentage of Hispanic or Latino (%)
(e)
y = −0.0133x + 29.147 r = −0.057 p = 0.0
Summer Nighttime Temp (°C)
Percentage of Asian alone (%)
(f)
y = −0.0095x + 29.819 r = −0.116 p = 0.0
Summer Nighttime Temp (°C)
Percentage of White alone (%)

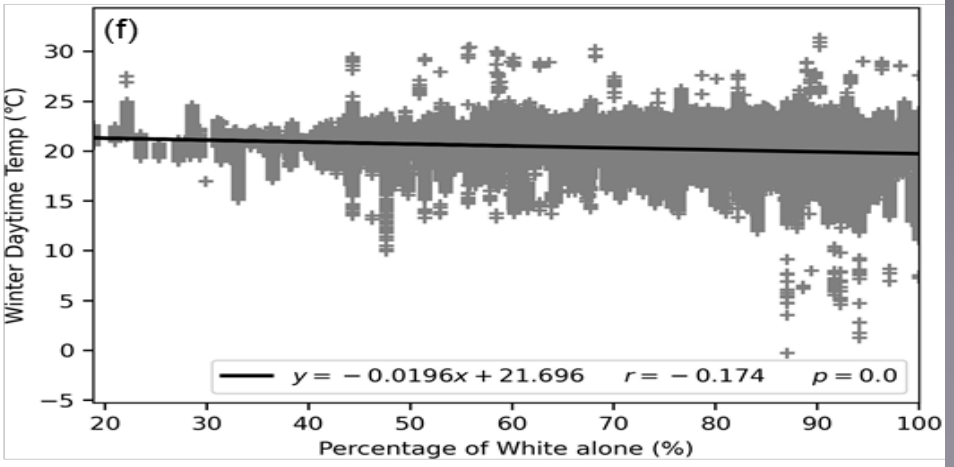

(a)
$y = 0.08x + 20.061$ $r = 0.14$ $p = 0.0$
Winter Daytime Temp (°C)
Percentage of American Indian and Alaska Native alone (%)


(b)
$y = 0.02x + 20.079$ $r = 0.086$ $p = 0.0$
Winter Daytime Temp (°C)
Percentage of Black or African American alone (%)

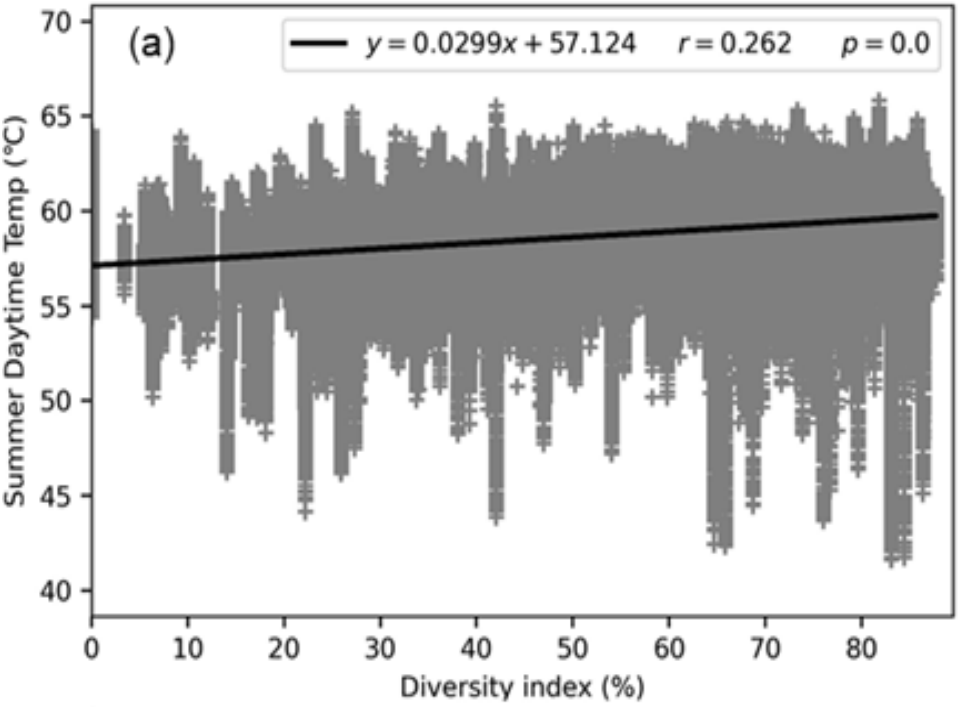

(c)
$y = 0.0527x + 20.197$ $r = 0.021$ $p = 0.0$
Winter Daytime Temp (°C)
Percentage of Native Hawaiian and Other Pacific Islander alone (%)

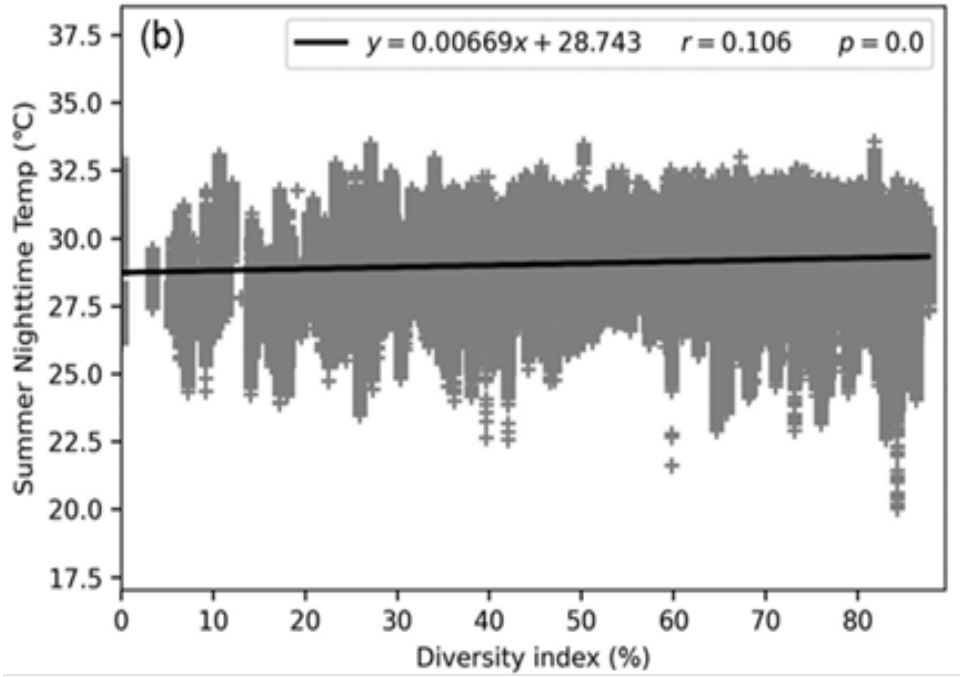

(d)
$y = 0.017x + 19.596$ $r = 0.26$ $p = 0.0$
Winter Daytime Temp (°C)
Percentage of Hispanic or Latino (%)

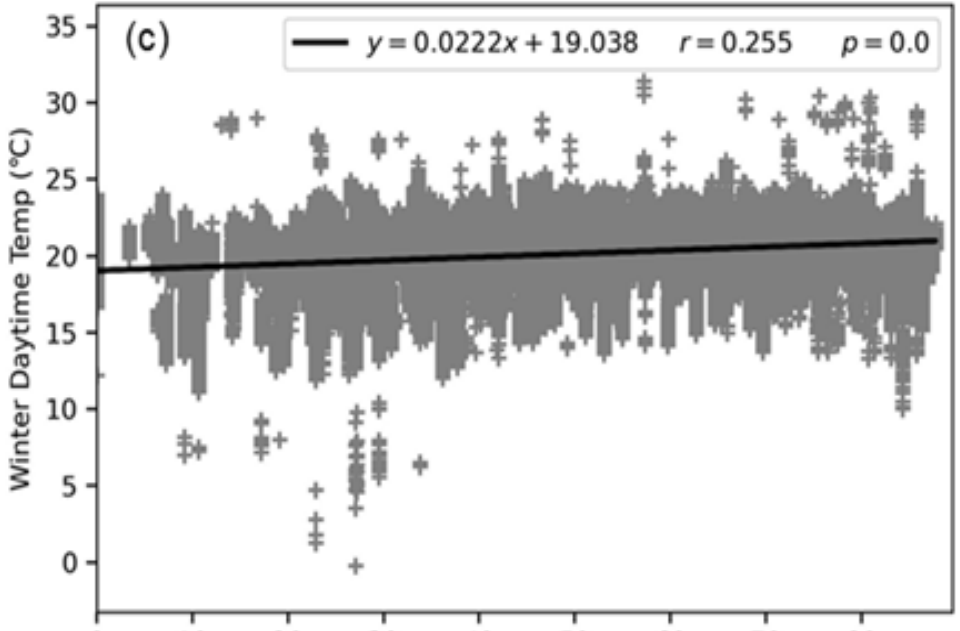

(e)
$y = -0.0176x + 20.275$ $r = -0.055$ $p = 0.0$
Winter Daytime Temp (°C)
Percentage of Asian alone (%)

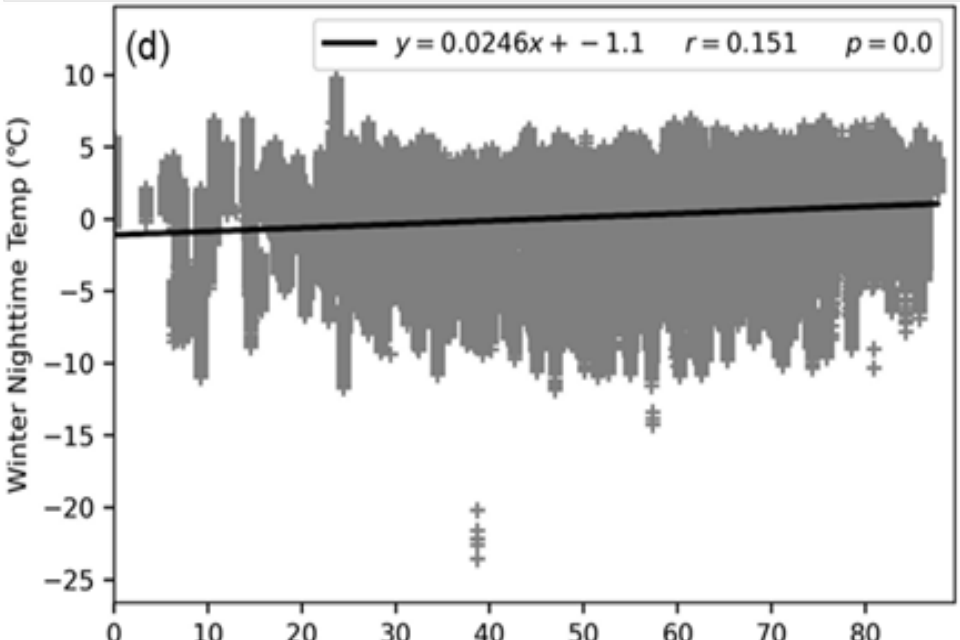

(f)
$y = -0.0196x + 21.696$ $r = -0.174$ $p = 0.0$
Winter Daytime Temp (°C)
Percentage of White alone (%)

Diversity Index









Conclusion

Household property values and median household income have significantly negative correlation with LST, suggesting that people with lower income level experience higher urban heat (higher LST).

A positive correlation is observed between percentage of household below poverty level and LST, demonstrating the environmental inequality or social justice.

The races of American Indian and Alaska Native alone (AA) and Black or African American alone (BL), have a consistently positive relationship with LST.

On the contrary, the races of Asian alone (AS) and White alone (WH) presented a consistently negative relationship with LST.

Hispanic or Latino (HI) was positively correlated with LST consistently. Conversely, Non-Hispanic (NH) has a negative relationship.

Diversity Index (DI) is significantly positively correlated with LST, indicating that a more diverse race/ethnicity situation would expose to higher LST.

Thank you!