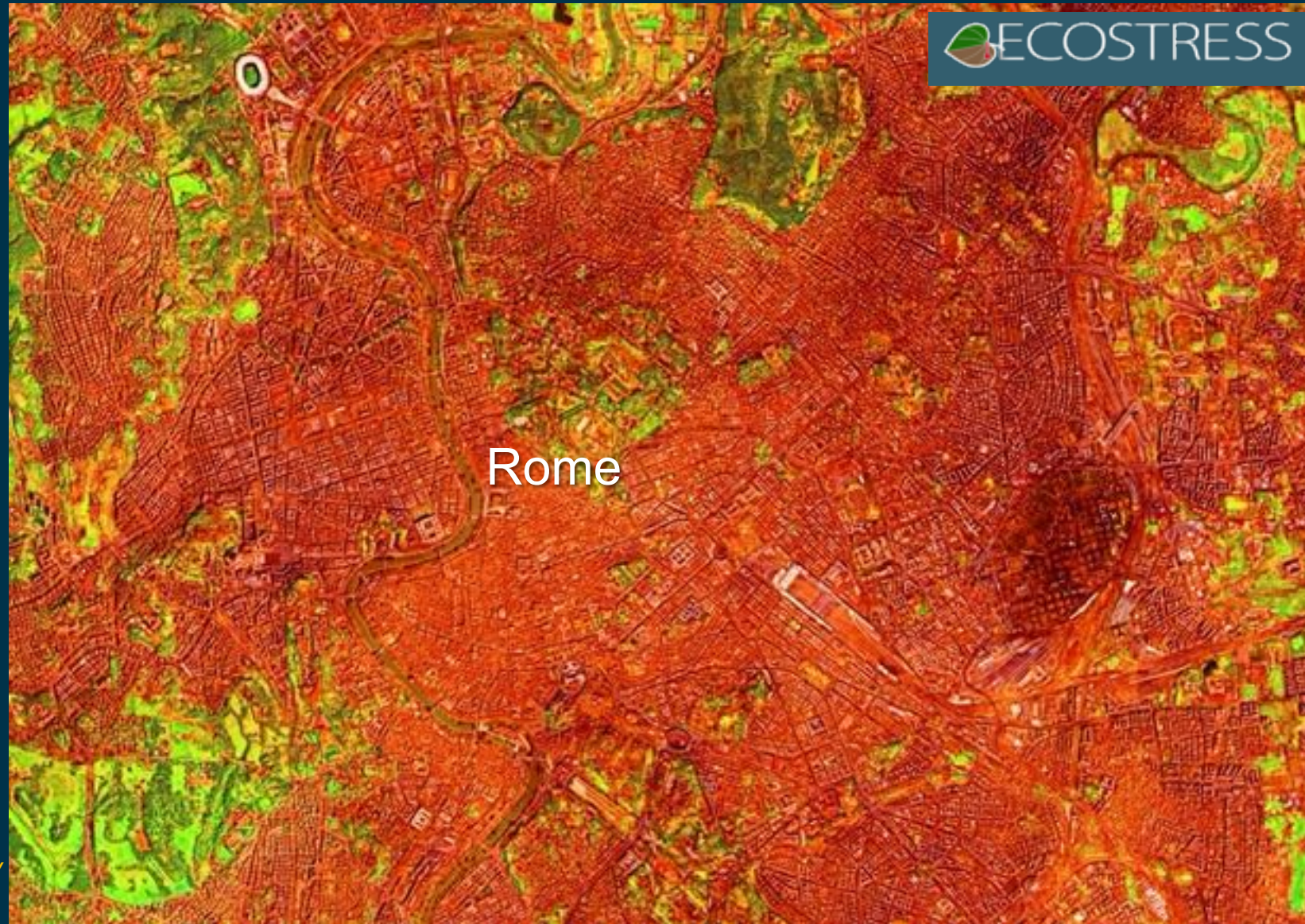




High resolution thermal imaging of urban heat islands and heat waves

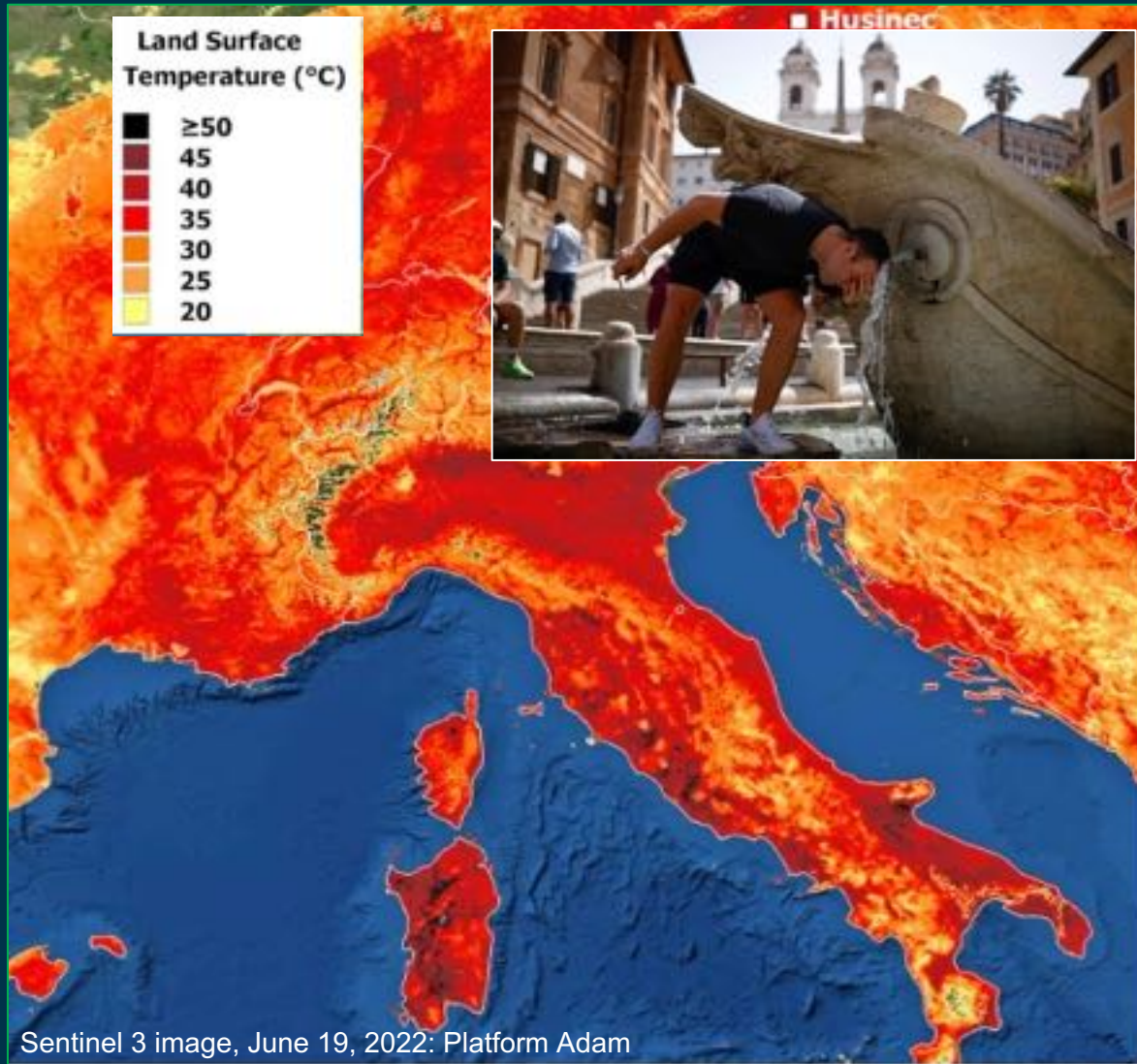


Glynn Hulley¹, Anamika Shreevastava¹
Yi Yin²

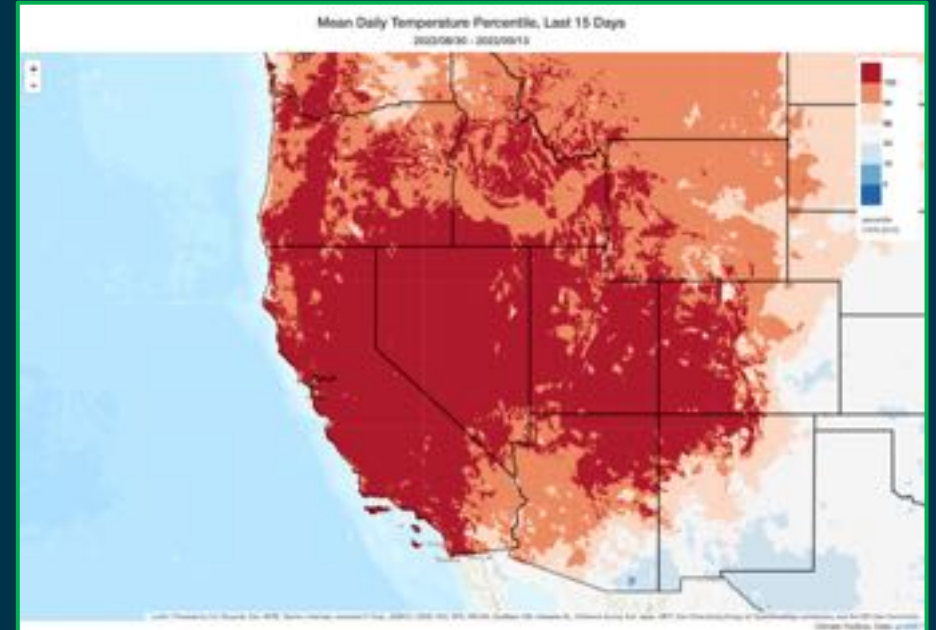
1. Jet Propulsion Laboratory, California Institute of Technology
2. California Institute of Technology

Urban extreme heat

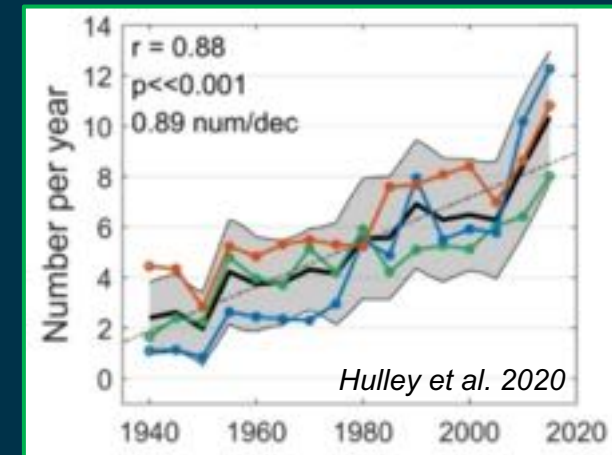
Rome reached its warmest temperature on record at 40.8°C in June, 2022





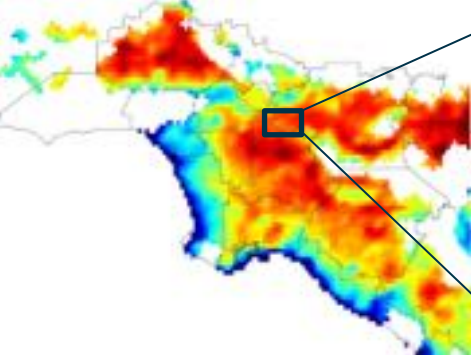
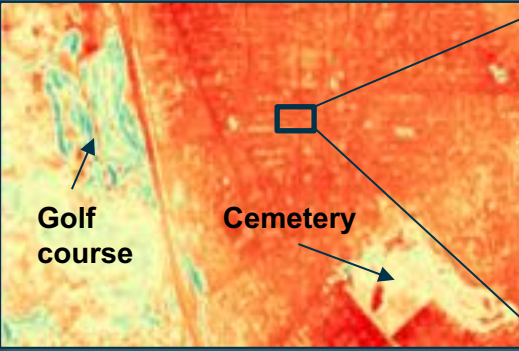
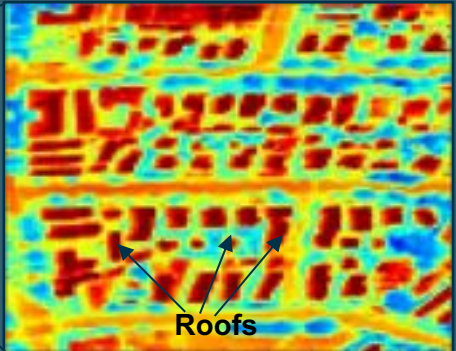
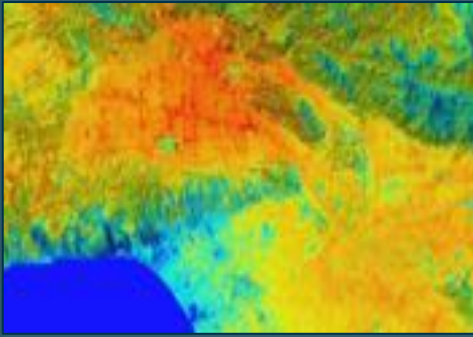


September 2022 heatwave was the **hottest ever on record** across the Western U.S



Urban heatwave frequency, duration, and intensity are increasing at record rates



Sensor	MODIS/VIIRS (2000/2002/2011)	ECOSTRESS (2018)	HyTES (2013)	Surface Biology Geology (SBG) (2027)
				
Platform	Aqua/Terra/S-NPP	International Space Station	Twin Otter/ER2	SBG-TIR
TIR bands	3	5	256	6 (+2 MIR)
Temporal	Twice Daily (1:30am/pm)	3-5 days	Campaigns	3 days
Spatial	1000 m	70 m (30m sharpened)	1 - 10 m	60 m
Example Imagery				

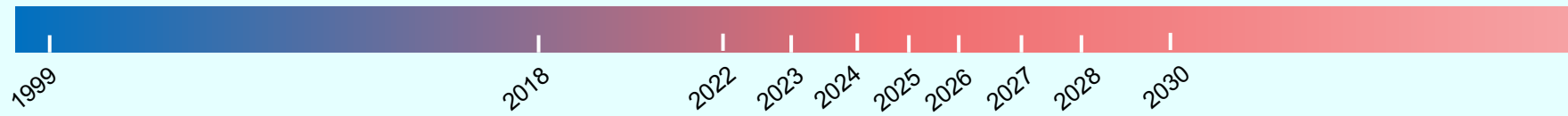
**MODIS
(2000/2002)**

**ECOSTRESS
(2018)**

**HyTES
(2013)**

SBG-TIR

High spatial resolution (<100m), multispectral (3+ bands) TIR program of record



ASTER on Terra
5 TIR bands (8-12 μ m)
90 m spatial resolution
16-day repeat cycle

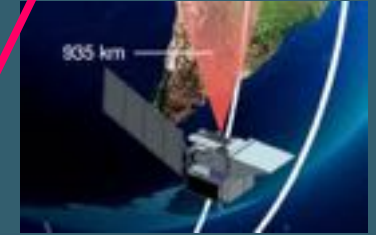
LSTM Copernicus Expansion (ESA)
5 TIR bands (8-12 μ m)
50 m spatial resolution
2-day repeat cycle

ECOSTRESS on ISS
5 TIR bands (8-12 μ m)
38 \times 69 m spatial resolution
1-5 day diurnal repeat cycle

Surface Biology Geology (NASA)
6 TIR bands (8-12 μ m)
2 MIR bands (3-5 μ m)
60 m spatial resolution
3-day repeat cycle

TRISHNA (CNES/ISRO)
4 TIR bands (8-12 μ m)
60 m spatial resolution
3-day repeat cycle

Landsat NEXT
5 TIR bands (8-12 μ m)
60 m spatial resolution
6-day repeat cycle (3x sensors)



SBG-TIR

6

3 days

60 m

Land Surface Temperature (LST) for monitoring extreme heat

2m Air Temperature – ERA5

Where and Who Experienced Extreme Temperature in April 2022

Estimated population who experienced more than

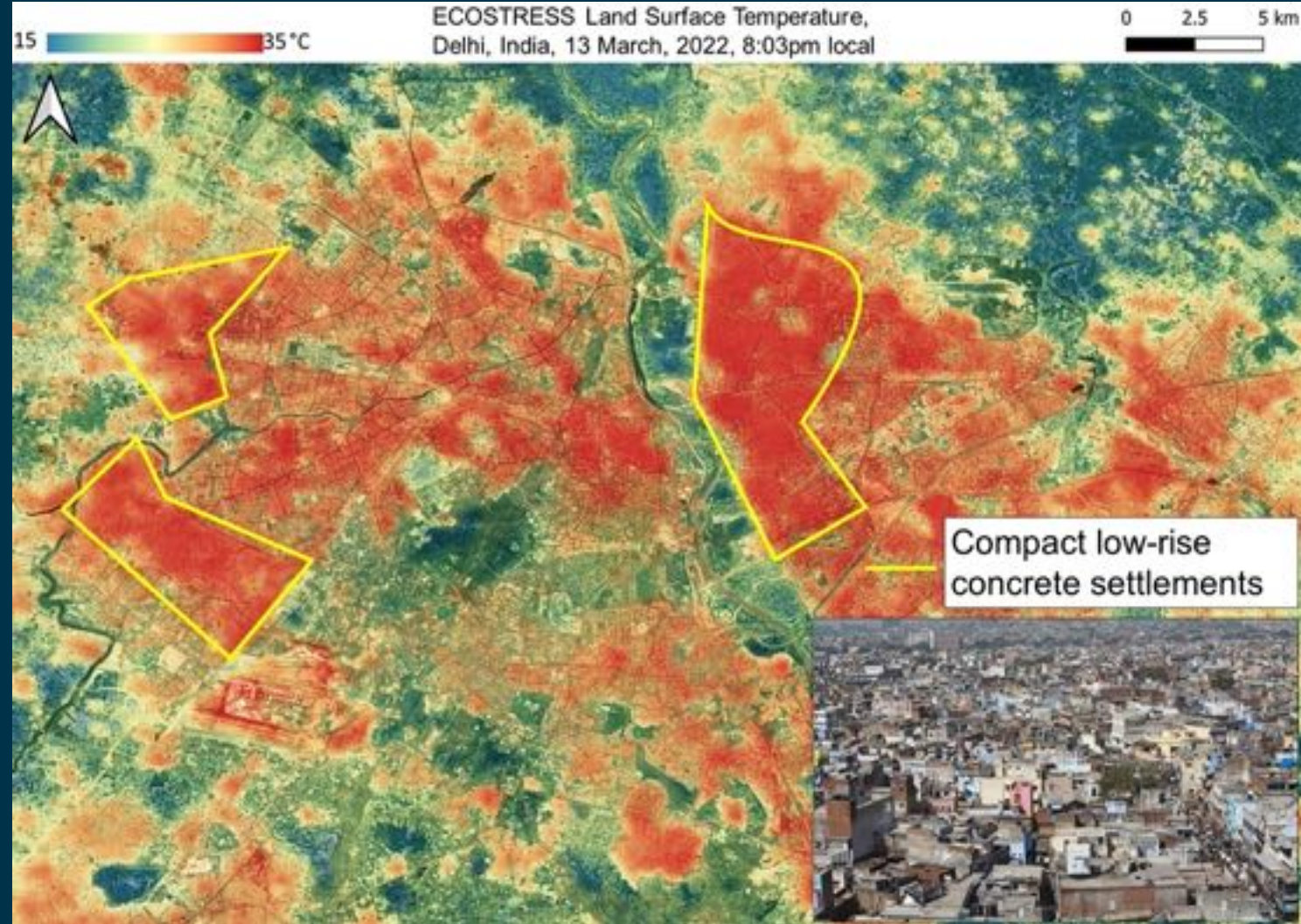
- ≥ 44°C: 13 crore, 9.4% of India's population
- ≥ 42°C: 53 crore, 38%
- ≥ 40°C: 90 crore, 65%

65% of India's population experienced temperatures >40 °C in April 2022

statsofindia.in
by @PratapVardhan

Data:
2m air temperature
from ERA5 Grid

Max temperature on any day of April



Identifying and quantifying urban heat island growth

Lucknow , India, 2013

■ Impervious surface
■ Pervious surface

Landsat 8

Lucknow , India, 2023



ECOSTRESS 30m nighttime LST

Congested residential hotspots

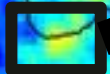
Airport

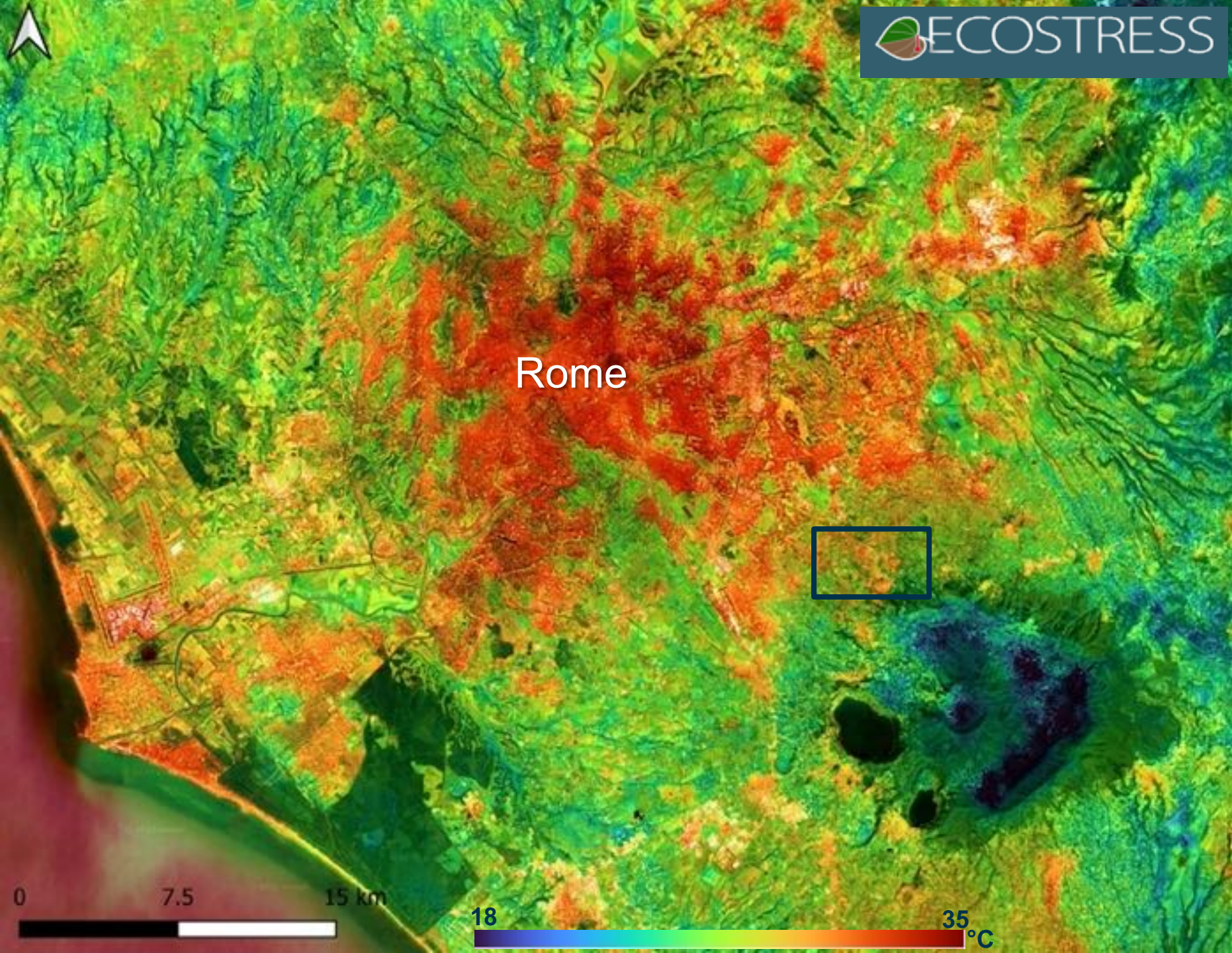
15 35 °C

VIIRS 375-m Nighttime LST, Lucknow, 2013

VIIRS 375m LST

VIIRS 375-m Nighttime LST, Lucknow, 2023





ECOSTRESS
sharpened land surface
temperature (30m)
image overlaid on
Google Earth

Rome, Italy
25 July, 2022, 09:23 pm

ESA-ESRIN

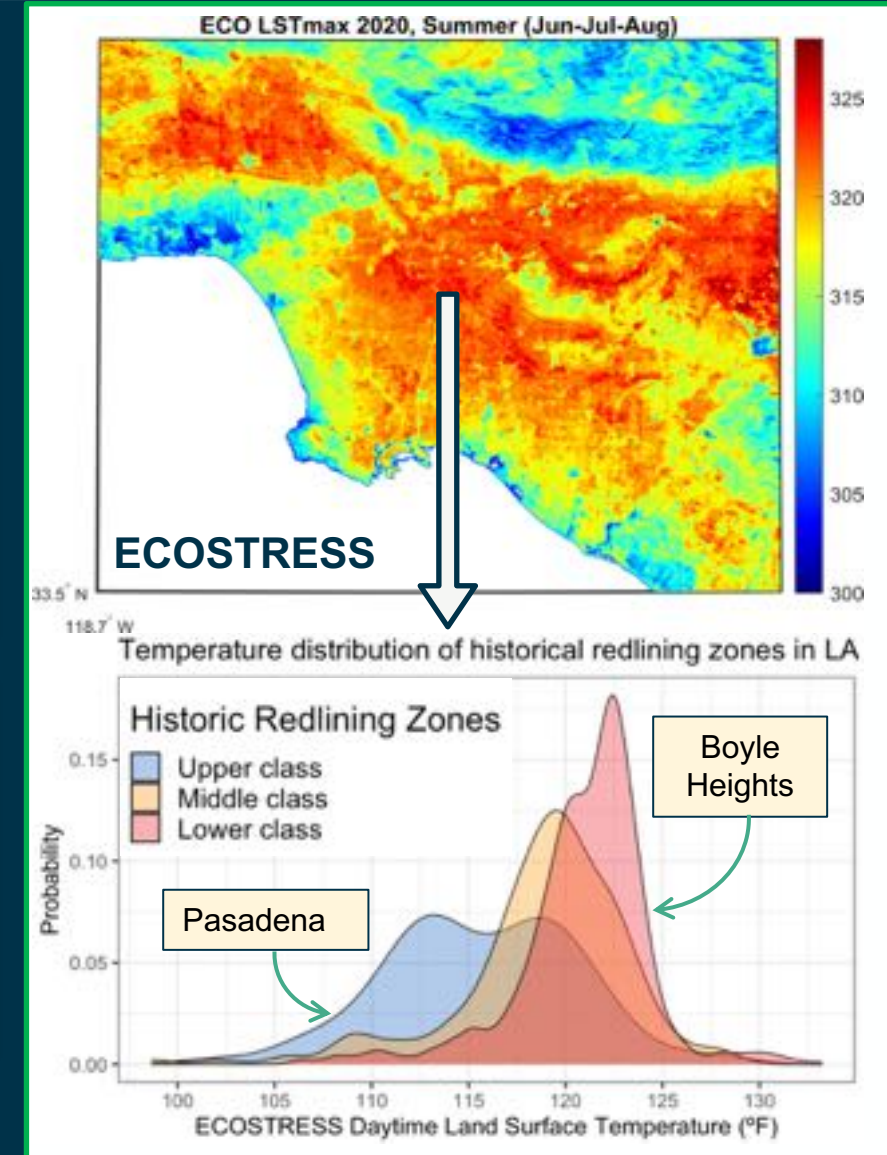


Frascati



Revealing inequities in extreme heat impacts

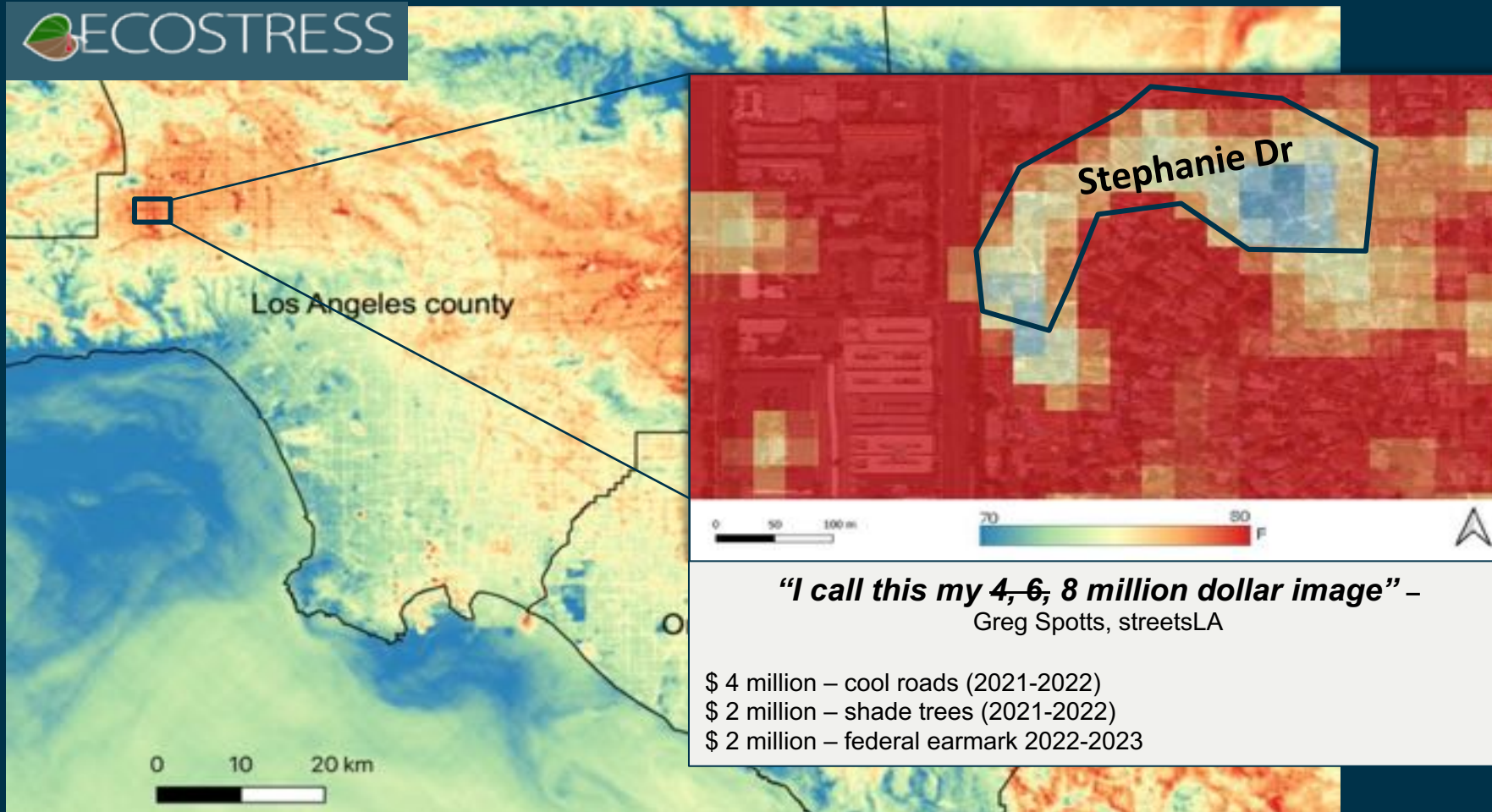
POORER NEIGHBORHOODS ARE UP TO 15°C WARMER



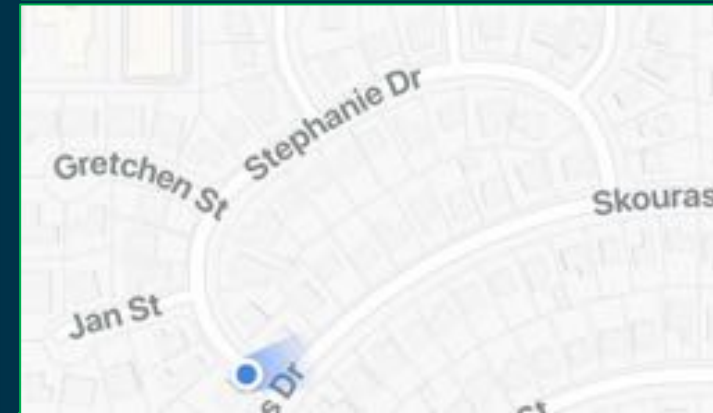
Redlining = discriminatory practice of segregating communities into areas less desirable to live in

Reducing heat and improving quality of life

REFLECTIVE COATING ON STREETS results in 2-3 °C cooling

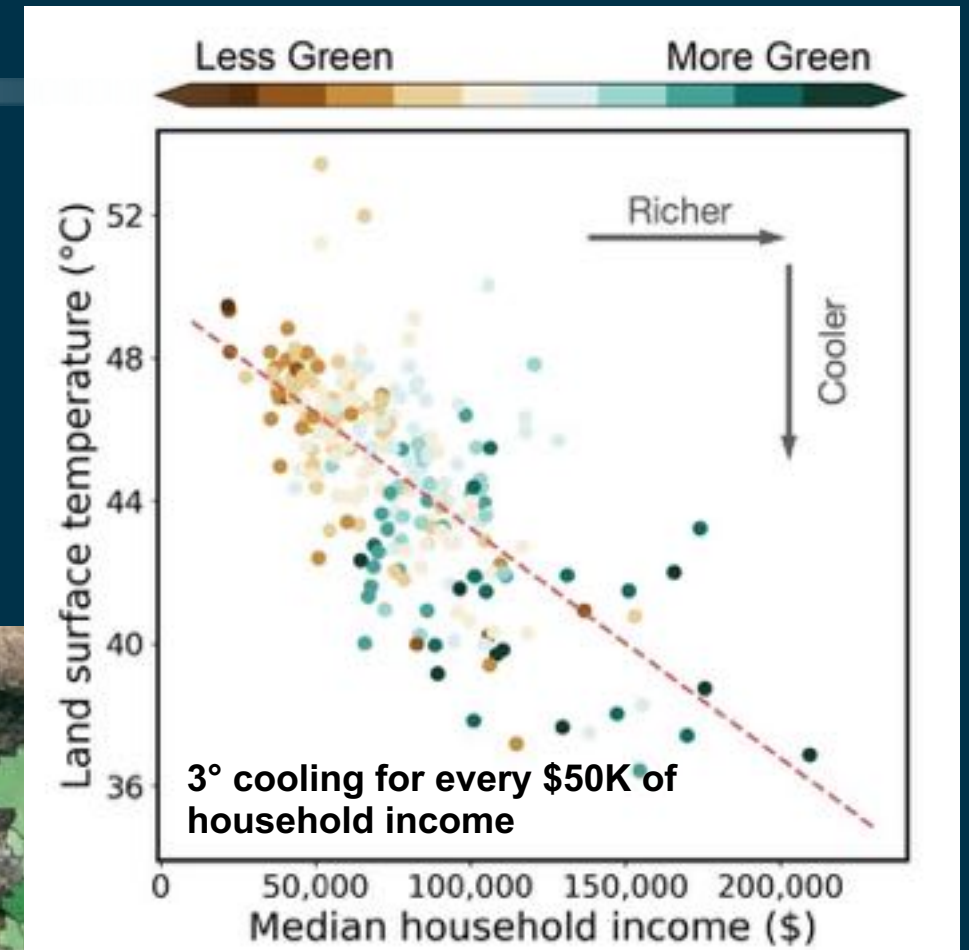
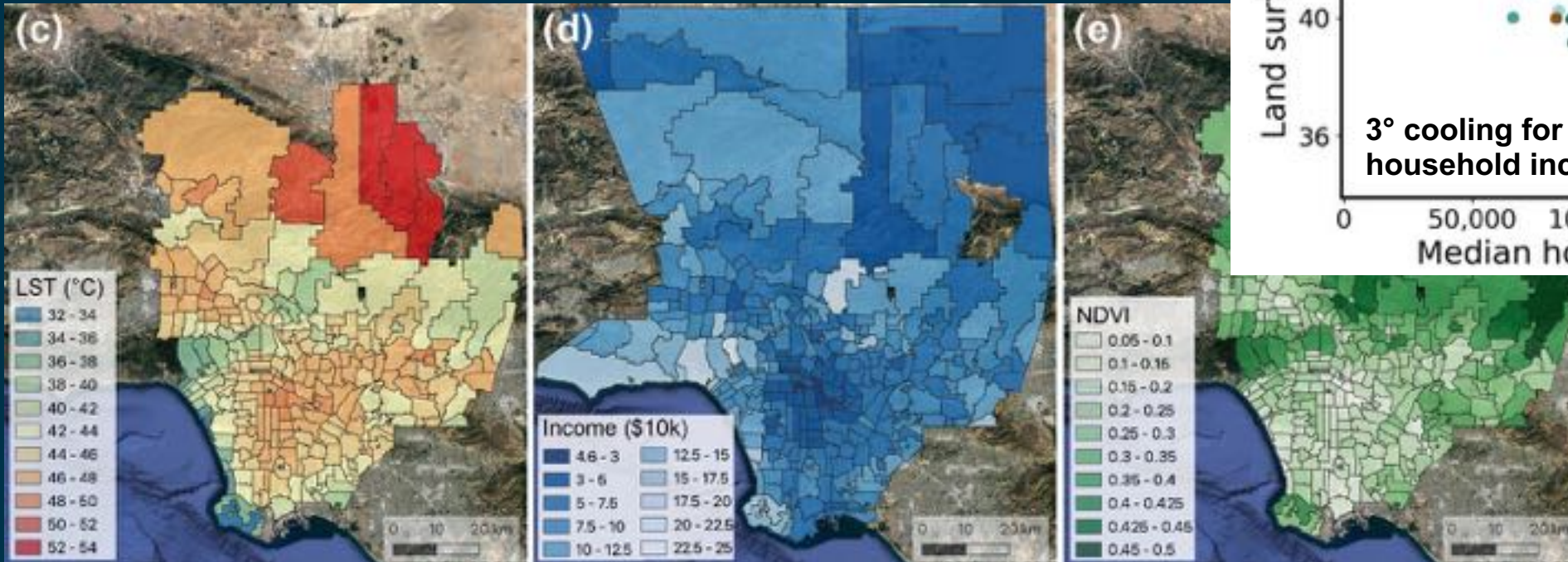


2017: StreetsLA cool neighborhood project



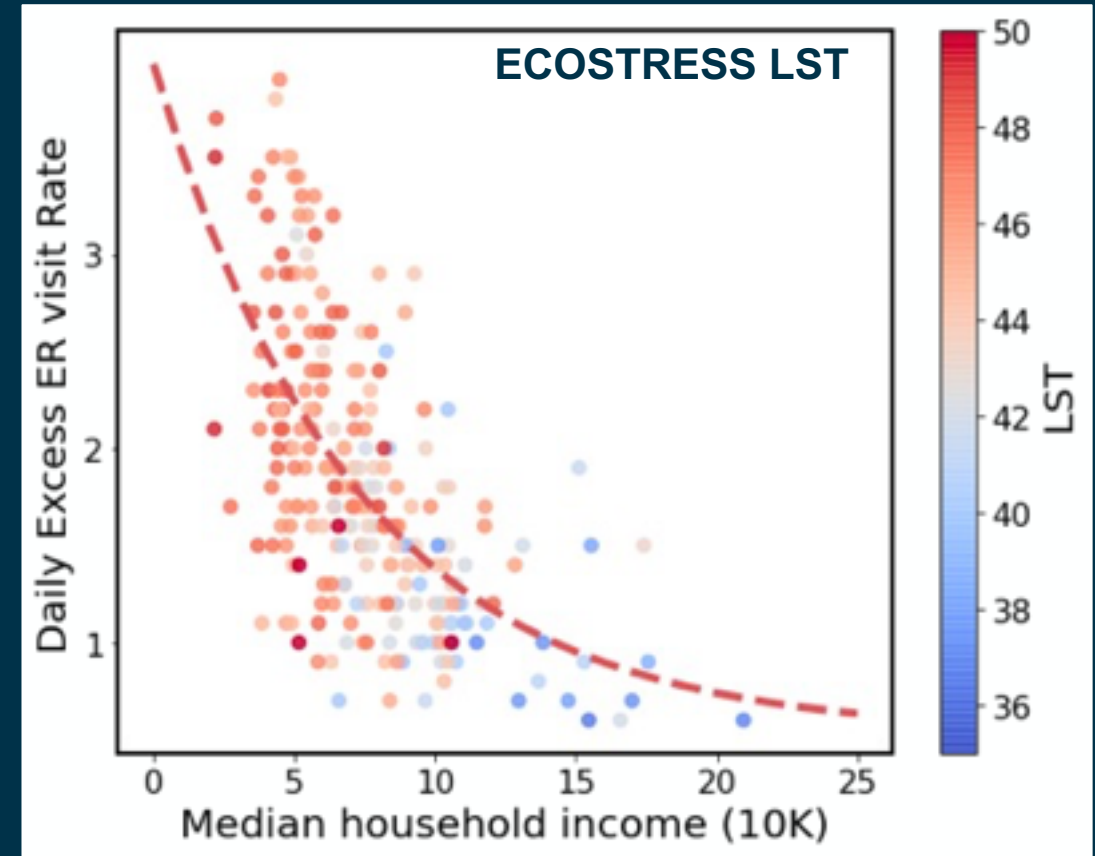
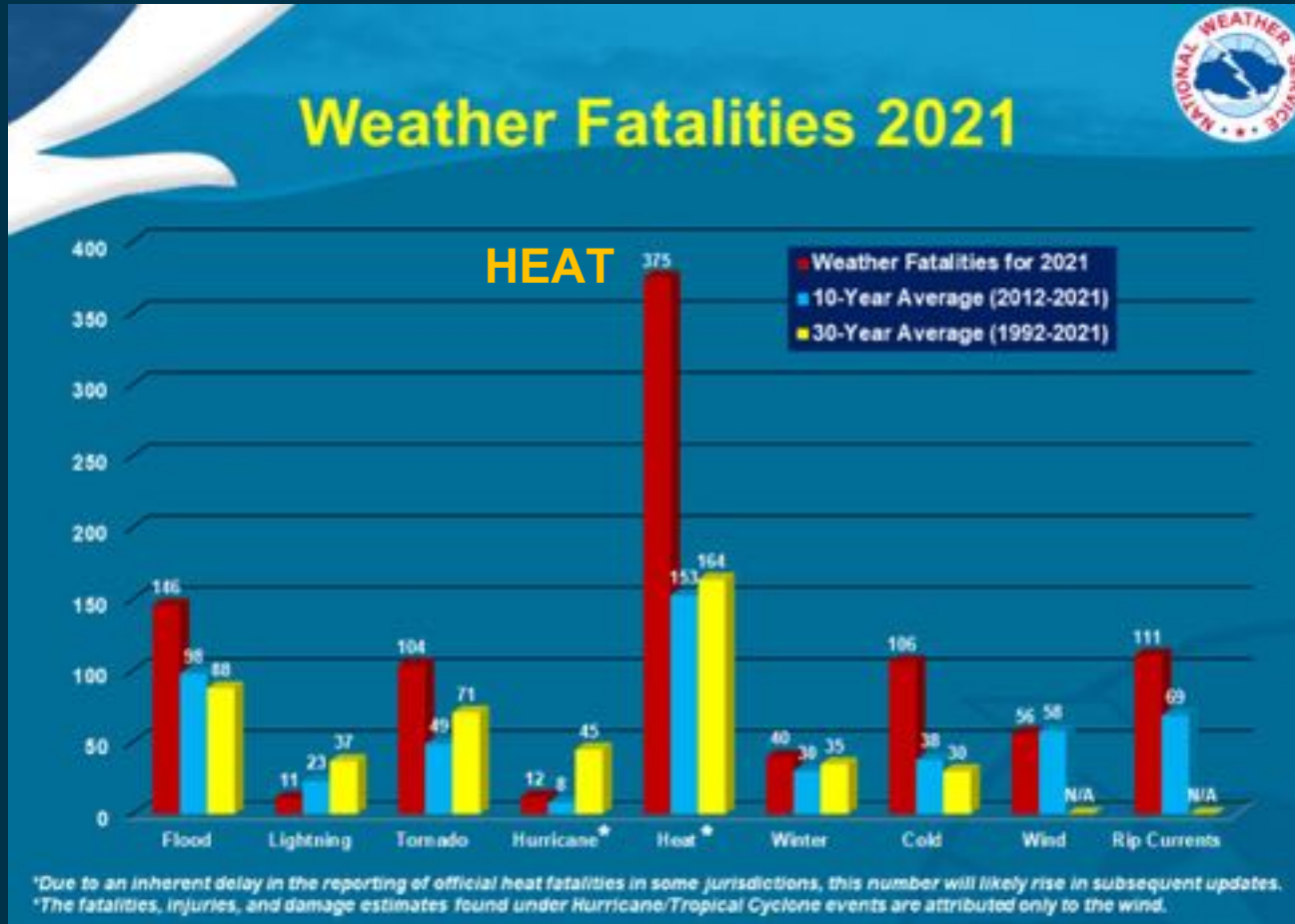
Inequality in heat exposure

Negative correlation between median household income and ECOSTRESS land surface temperature



Yin et al., 2023, *Science Advances*

Increased ER visits during extreme heat events



Yin et al., 2023, in prep

- Heat cramps, and heatstroke (hyperthermia) most common ER visits
- Other underlying health issues often overlooked, e.g. mental health, cognitive function.

Locals use fountains to cool of as downtown Rome reached its warmest temperature on record at 40.8°C in June, 2022.



Credit: ([Guglielmo Mangiapane/Reuters](#))

Questions?

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