

# Climate Change: A Deeper Look



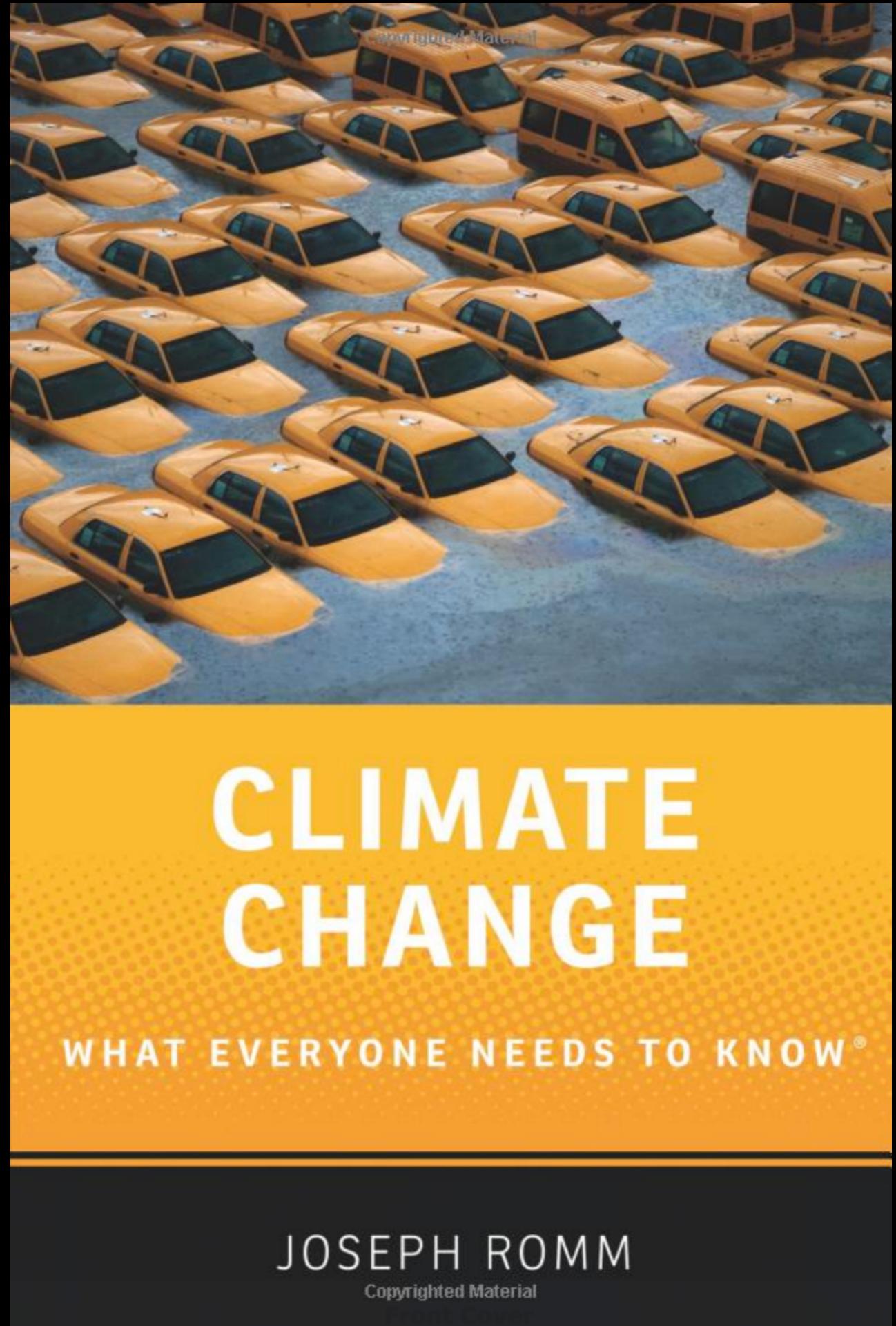
Patrick Drew

GSPS  
September 7

This talk based on:

Check it out if  
you want more

\$14 new on Amazon



## 1 Climate Science Basics

- What is the greenhouse effect and how does it warm the Earth? 1
- Why are scientists so certain the climate system is warming? 2
- How does global warming increase sea levels and what has been observed to date? 4
- Where does most of human-caused warming go? 6
- What fraction of recent global warming is due to human causes versus natural causes? 7
- How certain are climate scientists that humans are the primary cause of recent warming? 9
- How do scientists know that recent climate change is primarily caused by human activities? 9
- Why has the climate changed in the past, before there were human-caused greenhouse gas emissions? 12
- What are the climate system's amplifying feedbacks that turn a moderate initial warming into a big ultimate warming? 13
- Is the current level of atmospheric CO<sub>2</sub> concentration unprecedented in human history? 15
- Are recent climatic changes unprecedented? 17

## 2 Extreme Weather and Climate Change

- What is the difference between weather and climate? 31
- Which extreme weather events are being made worse by climate change and which are not? 32
- What is the role of natural climatic variation, such as the El Niño–La Niña cycle, in extreme weather? 34
- Did climate change cause Hurricane Sandy (and why is that the wrong question to ask)? 37
- How does climate change affect heat waves? 40

## 1

## 3 Projected Climate Impacts

- What kind of impacts can we expect this century from business-as-usual climate change? 73
- What are the biggest sources of uncertainty in projecting future global warming? 75
- What do previous hot periods in Earth's climate tell us about what the future may hold in store? 78
- How could the thawing permafrost speed up global warming beyond what climate models have projected? 80
- How could an increase in wildfires speed up global warming beyond what climate models have projected? 85
- What are some other key positive or amplifying feedbacks affecting the climate system? 88
- What will the impacts of sea-level rise be? 92
- How will climate change lead to more destructive superstorms this century? 96
- What kind of droughts can we expect this century? 98
- What are the expected health impacts of climate change? 103
- How does global warming affect human productivity? 107
- Does carbon dioxide at exposure levels expected this century have any direct impacts on human health or cognition? 112
- What is ocean acidification and why does it matter to sea life? 118
- What is biodiversity and how will climate change impact it? 121

## 73

Series of questions. This talk will look at some of them.

# Logic of the Book:

Imagine you knew  
about the internet  
25 years early.



How valuable would that info be?

How would you plan for the future?

# Climate Change Will Impact:

Health



Economies  
Politics  
Resources  
Wealth  
Climate (duh)  
Wars  
Migrant Crises  
More...

# What can we expect?

A nighttime satellite view of Earth from space, showing city lights and cloud formations.

Disclaimer: Some of these effects are likely to be at least partially mitigated.

# Humanity cannot avoid very serious climate impacts in the coming decades

Avoid worst impacts:

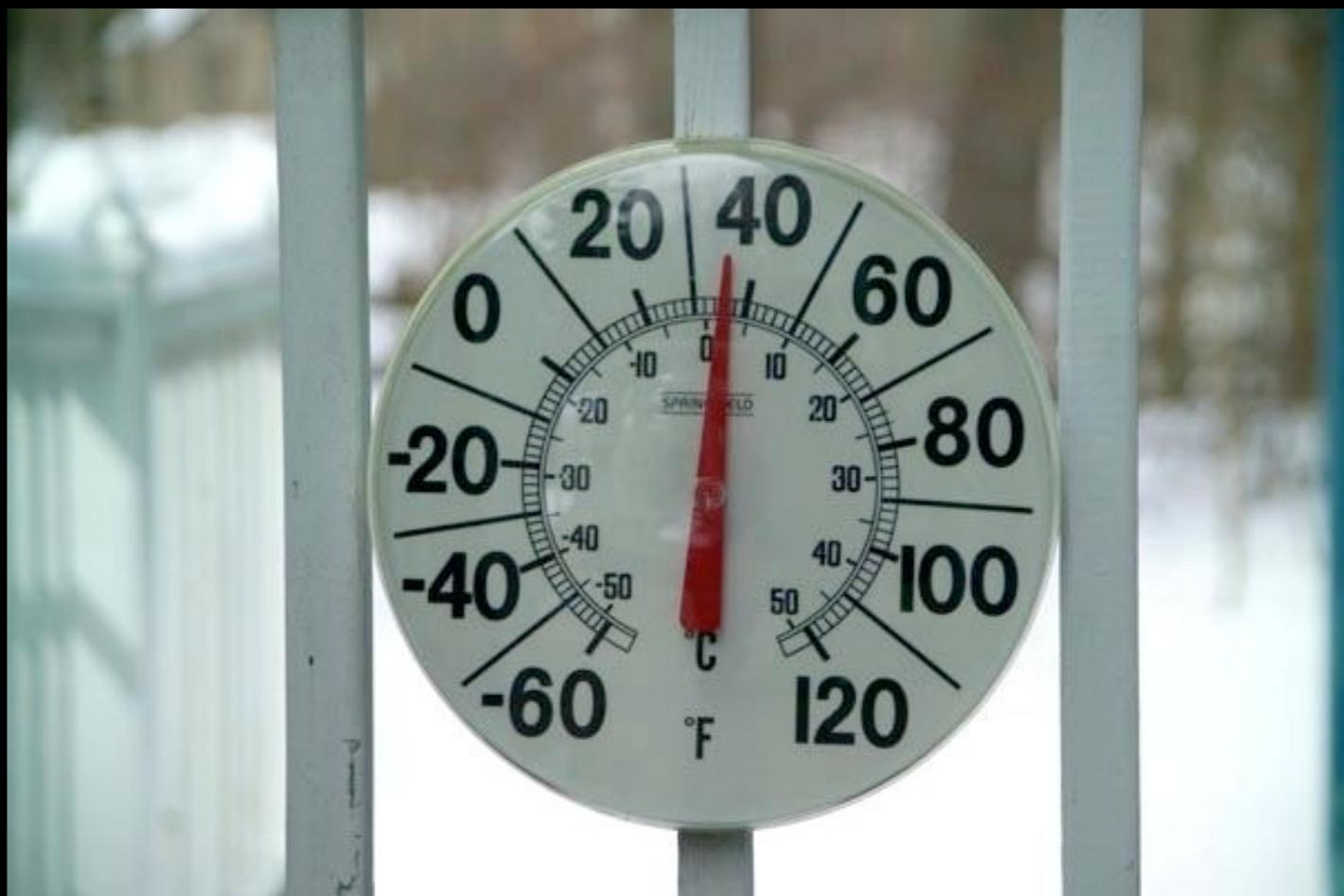
All nations to carbon-free energy faster than currently scheduled

<0 carbon emissions by 2100



# Warming

- 1900-1970: +0.5 F
- 1970-present: +1 F
- 2100: +7.5 F  
(business as usual)



## SATELLITE DATA: 1993-PRESENT

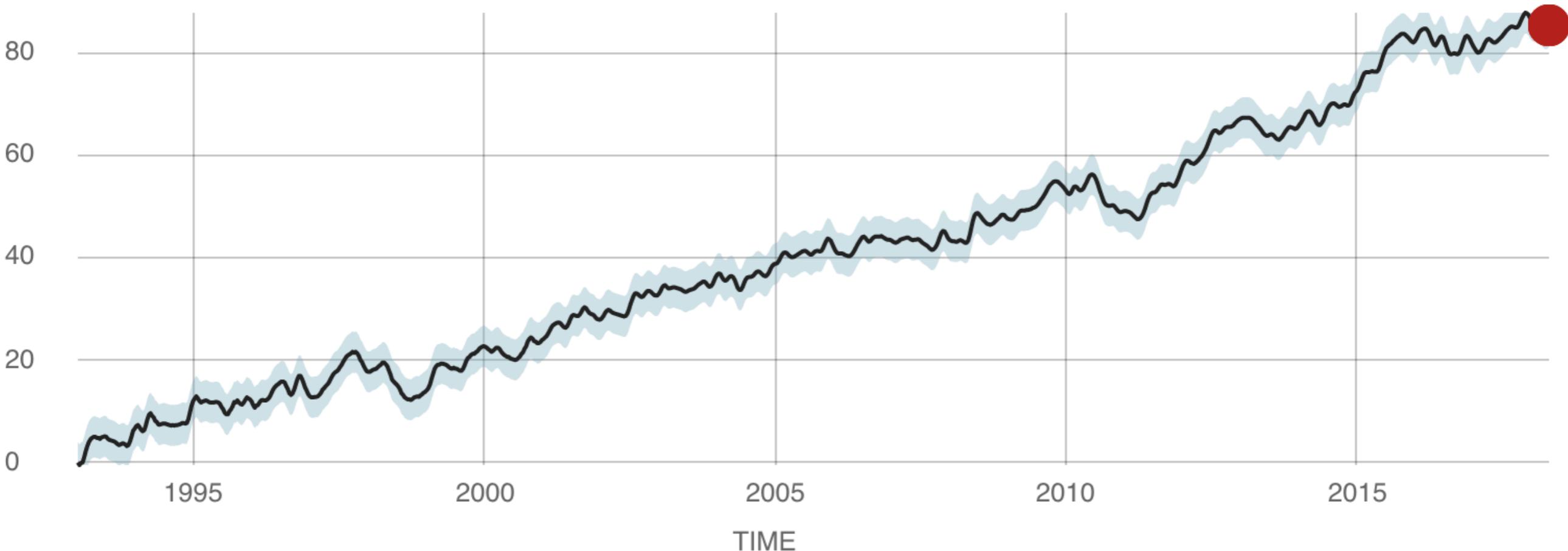
RATE OF CHANGE

Data source: Satellite sea level observations.

Credit: NASA Goddard Space Flight Center

↑ 3.2

millimeters per year



1 ft by 2050

>4-6 ft by 2100 with business as usual

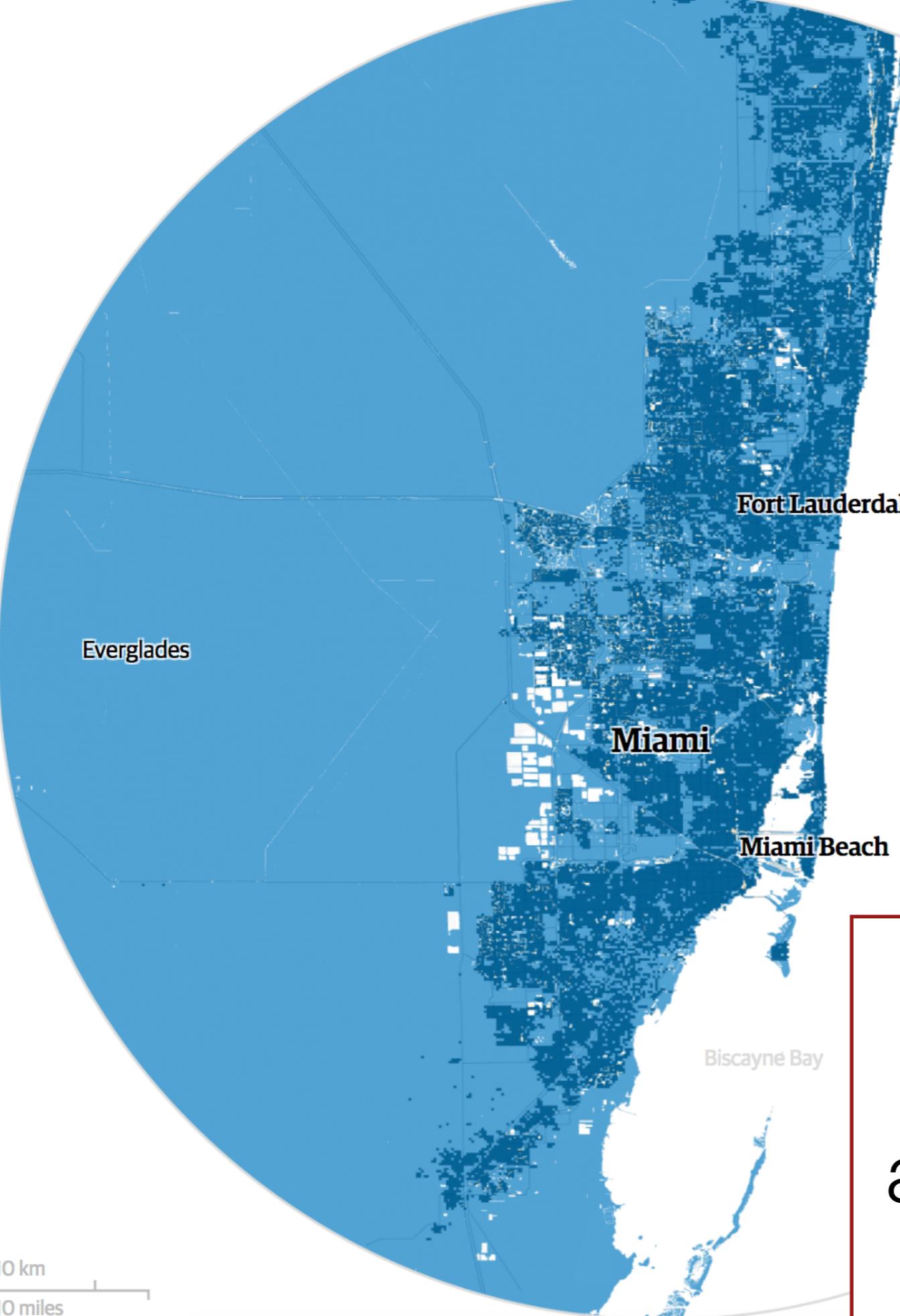
Every decade after 2100, >1 ft per decade!!  
(~0.08mm/day or 1mm every ~12 days)

# Impact 1: Sea Level Rise



# Hull, MA +6ft





2.7 million  
people affected

\$15 billion of  
coastal property  
at risk of flooding  
in next 15 years

# Florida +6ft

Even at +3 ft, 1/3 of southern Florida will swim.

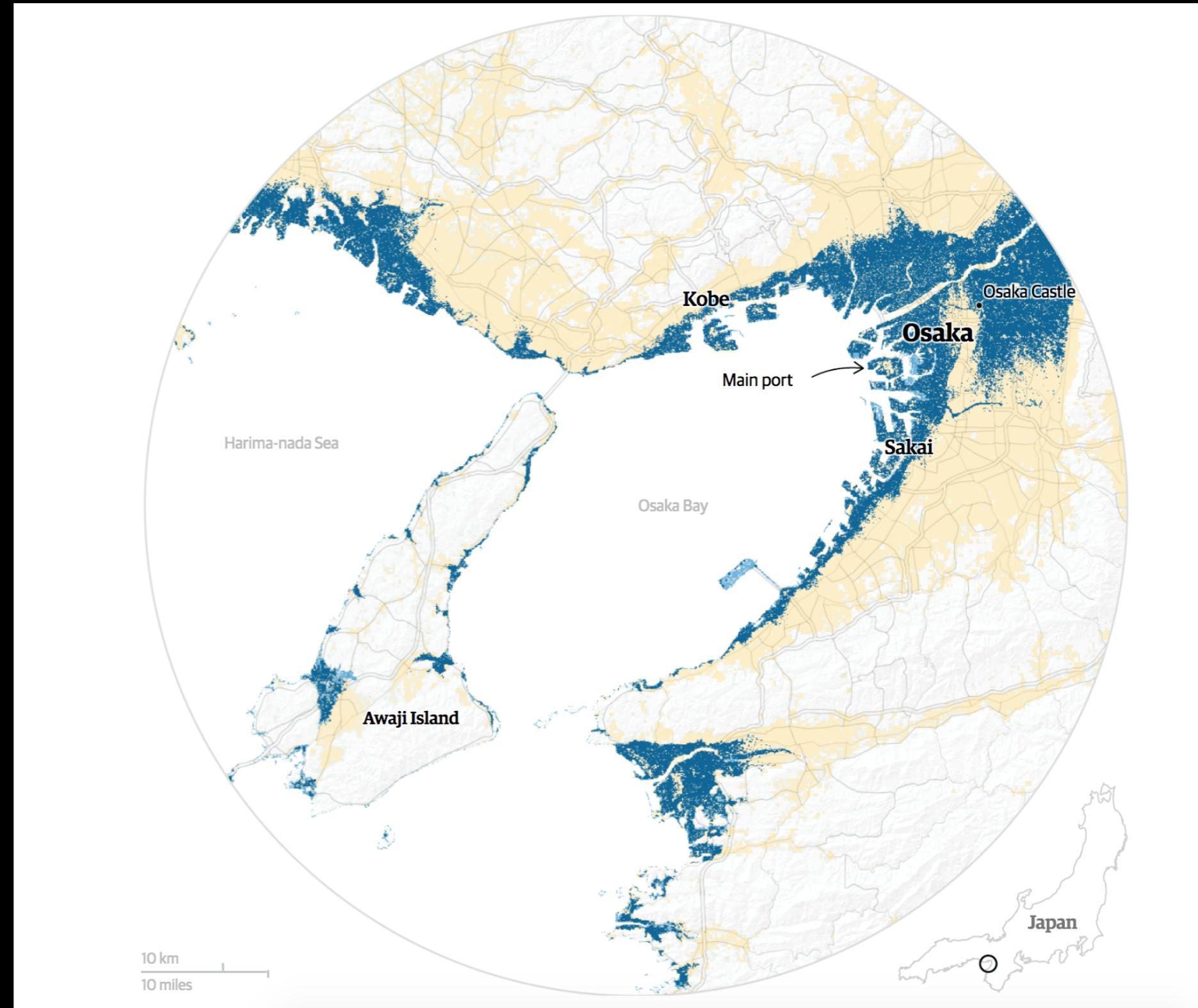
Storm surges and rising seas will cause property values to fall to nothing.

Real estate will be uninsurable.



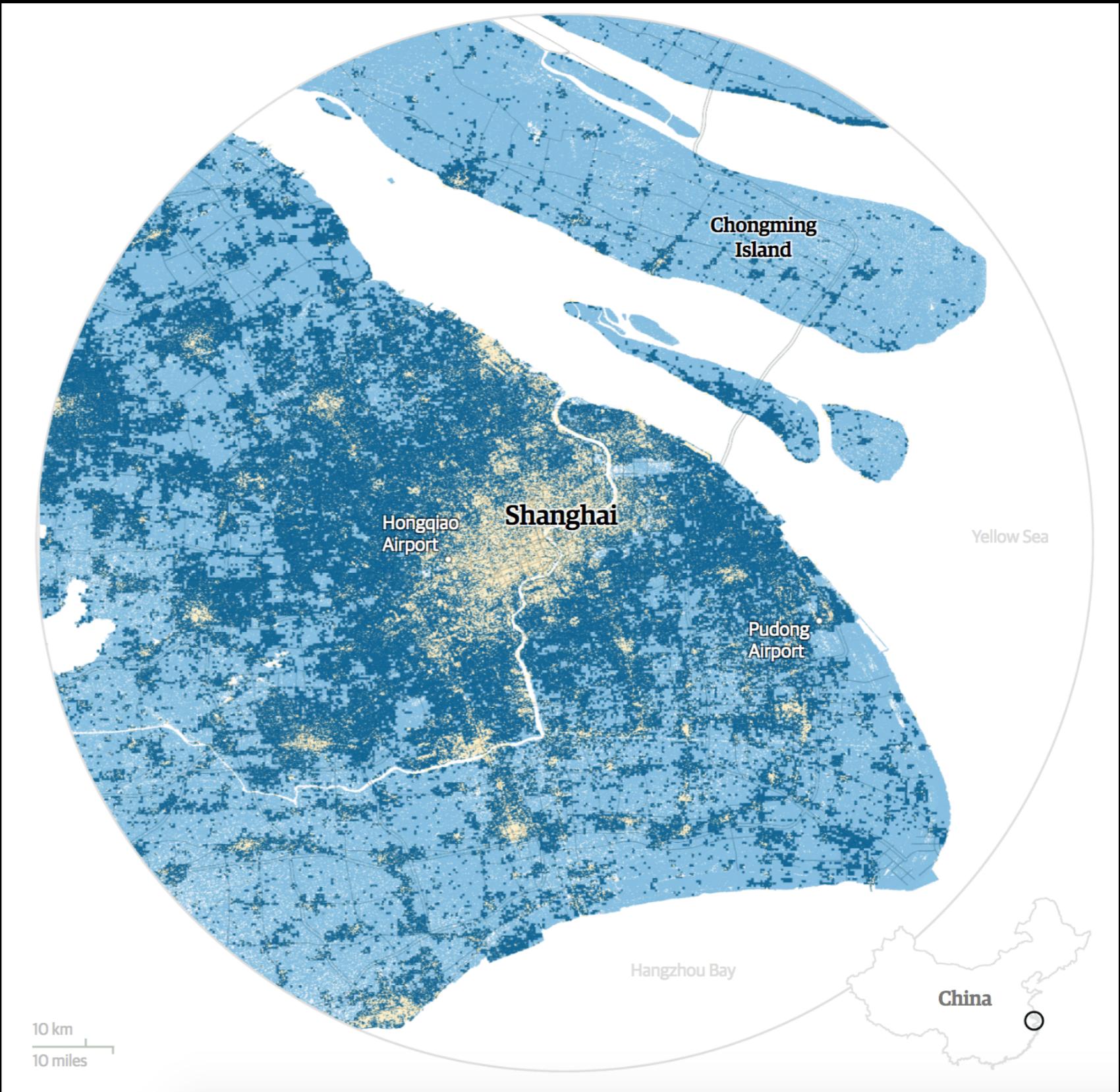
5.2  
million  
people  
affected

# Osaka



# Shanghai

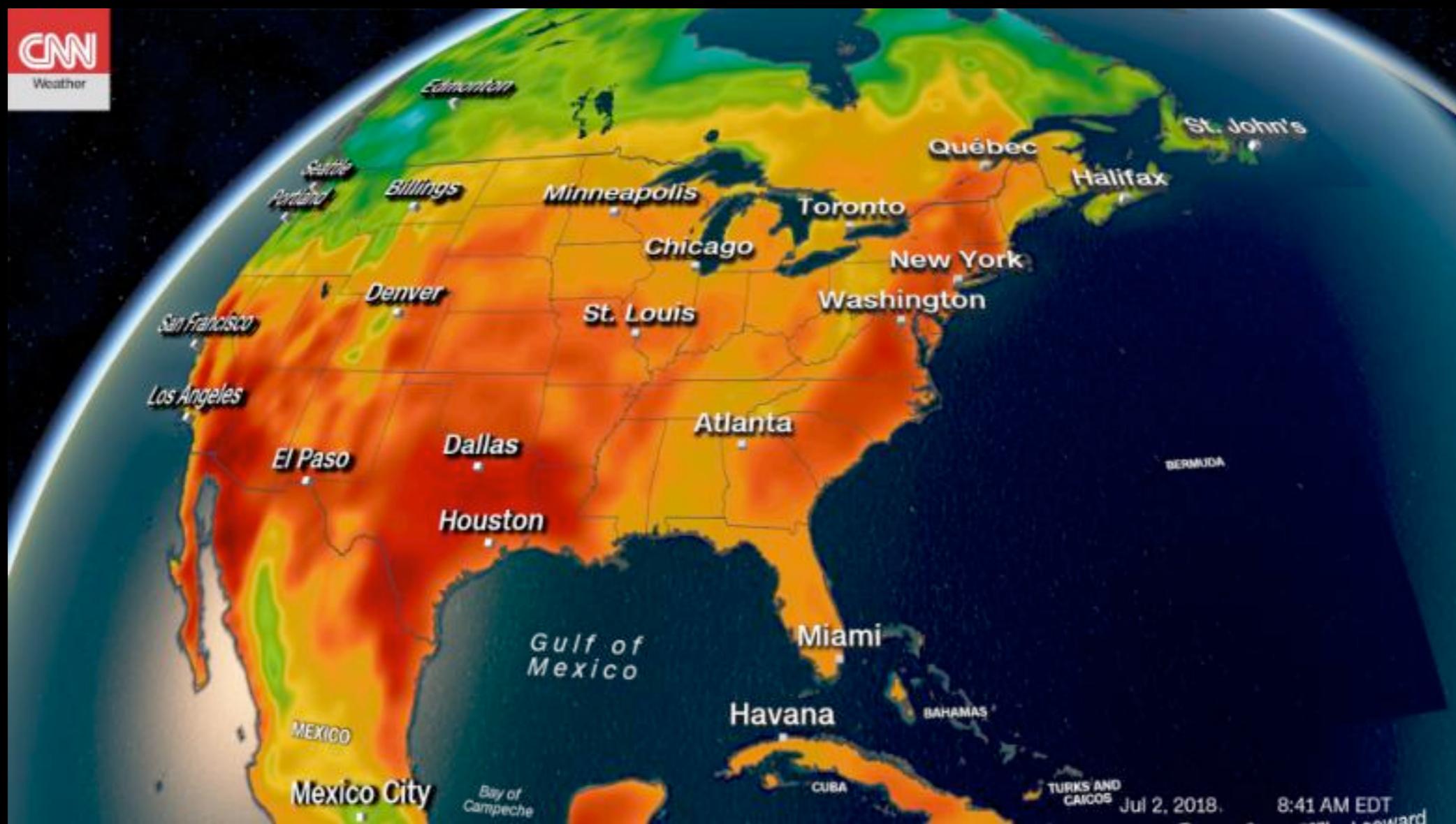
17.5  
million  
people  
affected



# Global migrant and real estate crises



# Impact 2: Heat Waves

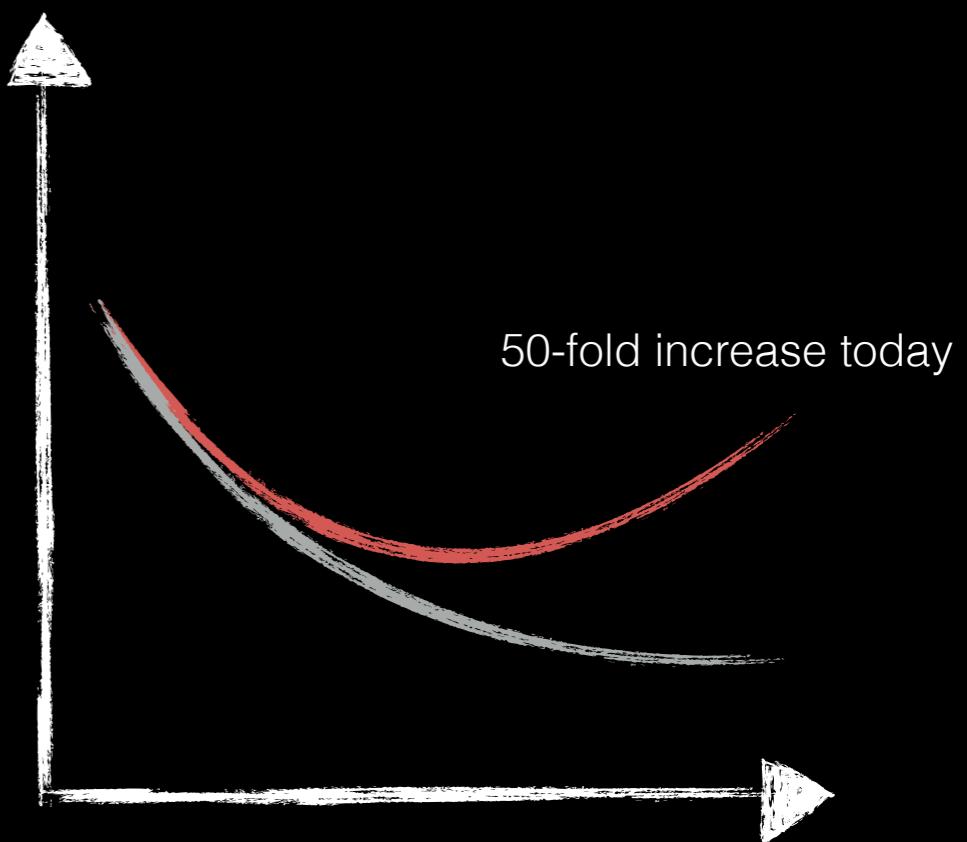


# Heat Wave Probabilities



- Probability of extreme events boosted more than moderate events

$P(\text{extreme})$



50-fold increase today

# 2003 European Heatwave

70,000 died,  
mostly elderly,  
many in France.

Culprit was lack of  
AC which is  
usually not  
needed.

Many vulnerable  
populations  
worldwide



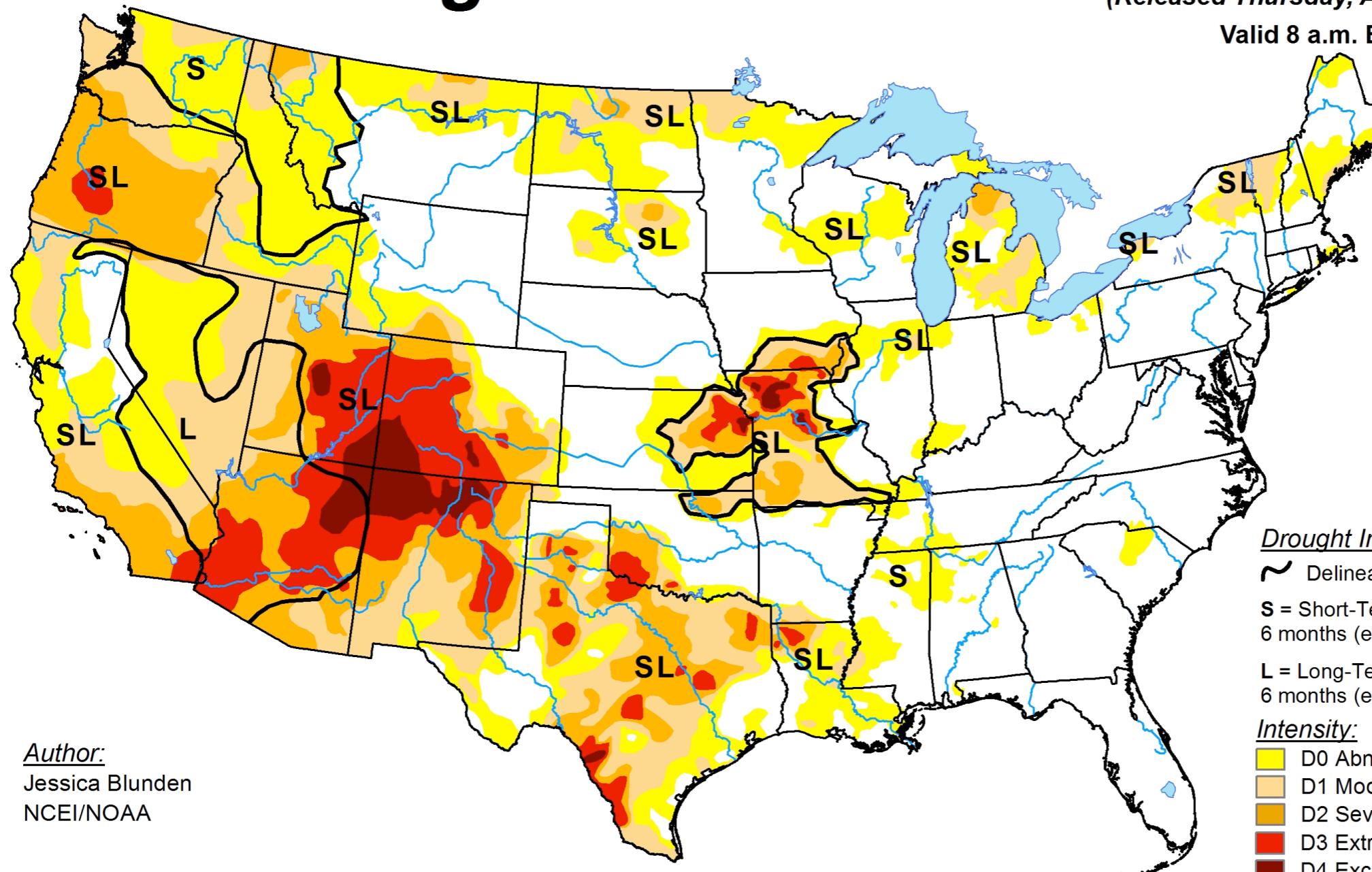
# Impact 3: Deeper, more frequent, and longer droughts



# U.S. Drought Monitor

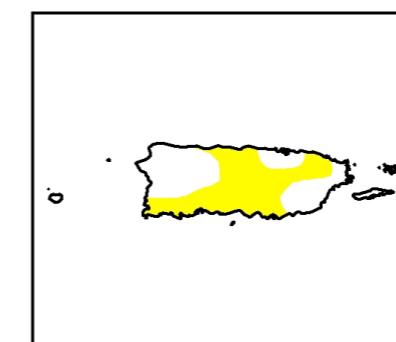
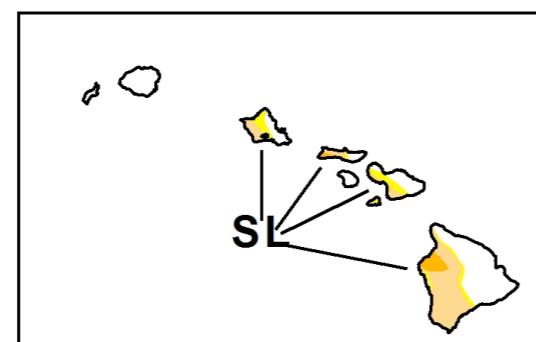
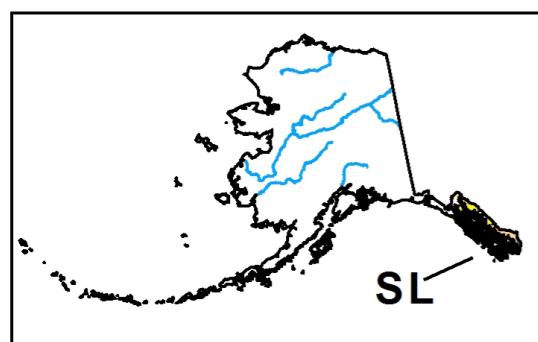
August 28, 2018  
(Released Thursday, Aug. 30, 2018)

Valid 8 a.m. EDT



Author:

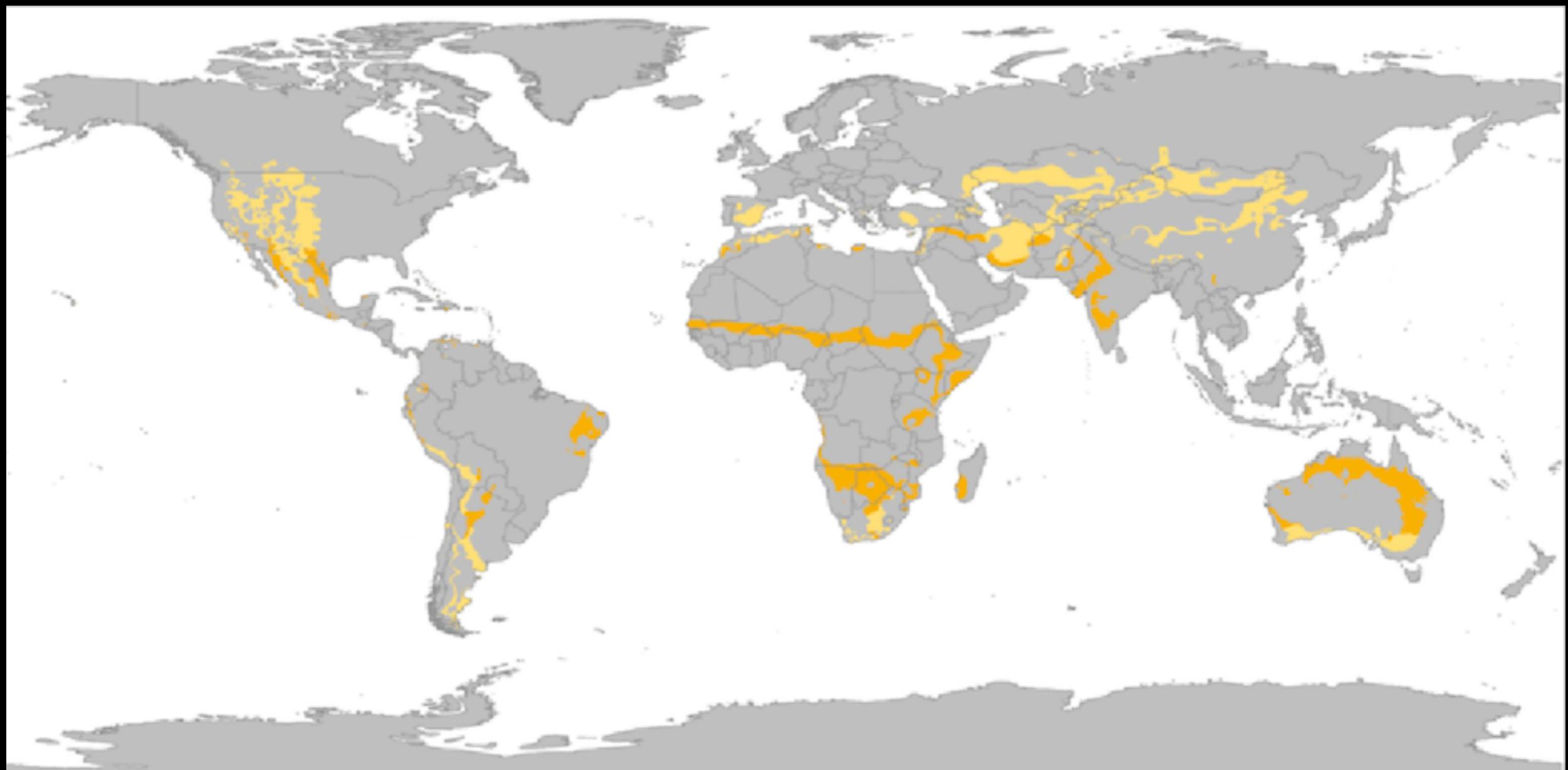
Jessica Blunden  
NCEI/NOAA



<http://droughtmonitor.unl.edu/>

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

# Semi-arid climates will become desert



# Dust bowl effects

SW US, SW Europe,  
and other hot, heavily  
populated and or  
heavily farmed land.

Food and water  
shortages.



# How to prepare:

- Save more money  
(e.g. soaring food prices)
- Don't plan to retire to US southwest, Mediterranean, or anywhere near the coast.



# Where to consider living/ buying land

northern midwest

- Places with relatively abundant water and arable land
- Real estate rush in coming decades
- There are no regions that “win”, however.



northern europe



# Land rush

- Nobody can say when people in US will start moving north, but it is certain to happen.
- People who plan ahead will come out ahead



(Klondike Gold Rush)



MUSÉE McCORD MUSEUM

# The Upside

- Energy experts say even the strongest climate change action is now super cheap.
- Makes fiscal sense to transition from fossil fuels to renewables.
- Effects visible soon will change tunes of many deniers.



79% of Hawaiians believe.  
Rainfall decreased, but intensity increased



# Things I didn't fit in:

- Best and worst case scenarios
- How to avoid the worst case scenarios
- How renewables have become so cheap recently
- Other dangerous climate effects
- Positive (and negative?) feedback loops
- Health impacts of climate change
- Dozens of other things. Buy the book!

# Let's go to crown

- ~550 ft above sea level
- High temps :(
- Has beer



# Sources

- “Climate Change” by Joseph Romm
- <https://www.jpl.nasa.gov/edu/teach/activity/graphing-sea-level-trends/>
- <https://www.businessinsider.com/miami-floods-sea-level-rise-solutions-2018-4>
- <https://www.theguardian.com/cities/ng-interactive/2017/nov/03/three-degree-world-cities-drowned-global-warming>