

Climate Change and Extreme Weather

Lauren Casey, Meteorologist
Berks Nature Presentation
November 3rd, 2022

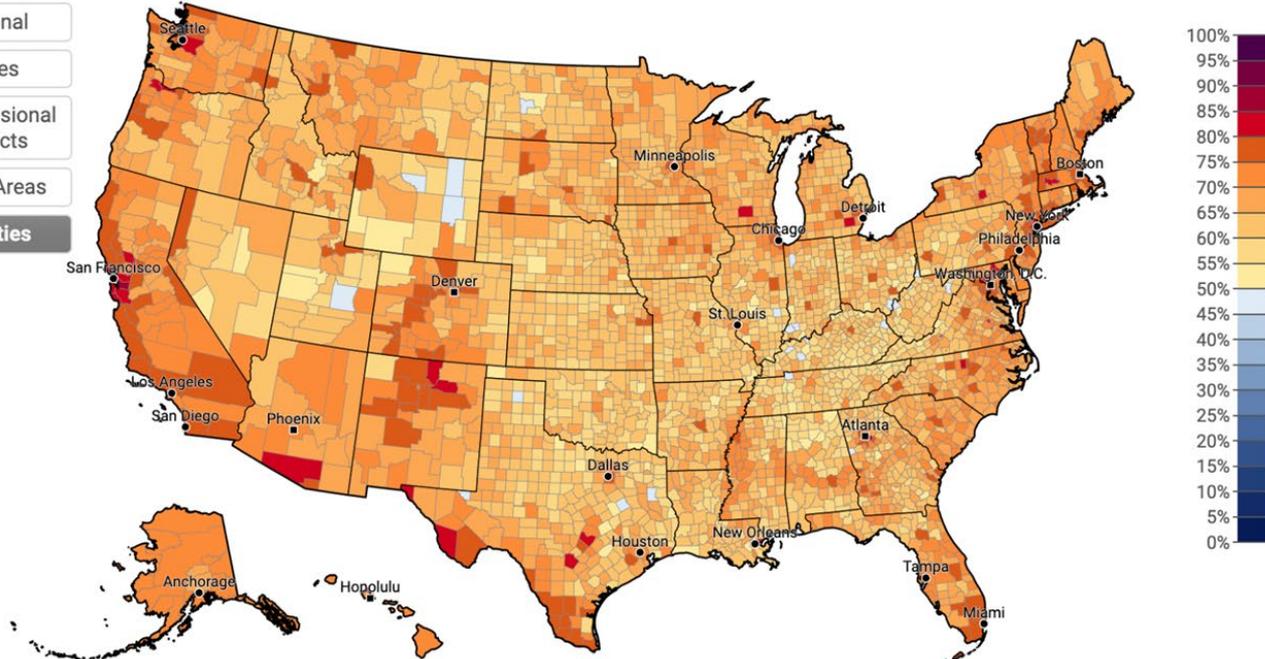


Estimated % of adults who think global warming is happening (nat'l avg. 72%), 2021

Select Question:

Click on map to select geography, or:

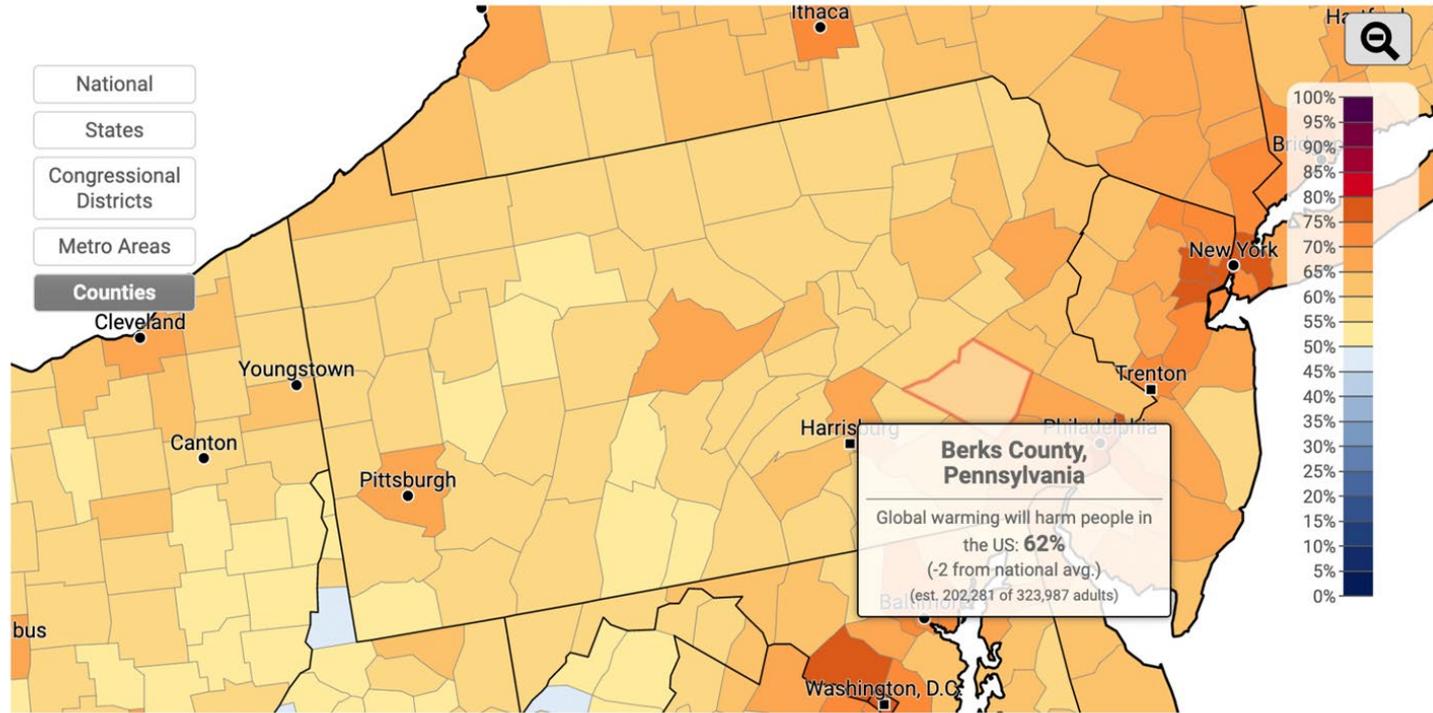
- National
- States
- Congressional Districts
- Metro Areas
- Counties**



Estimated % of adults who think global warming will harm people in the US (nat'l avg. 64%), 2021

Select Question: Absolute Value

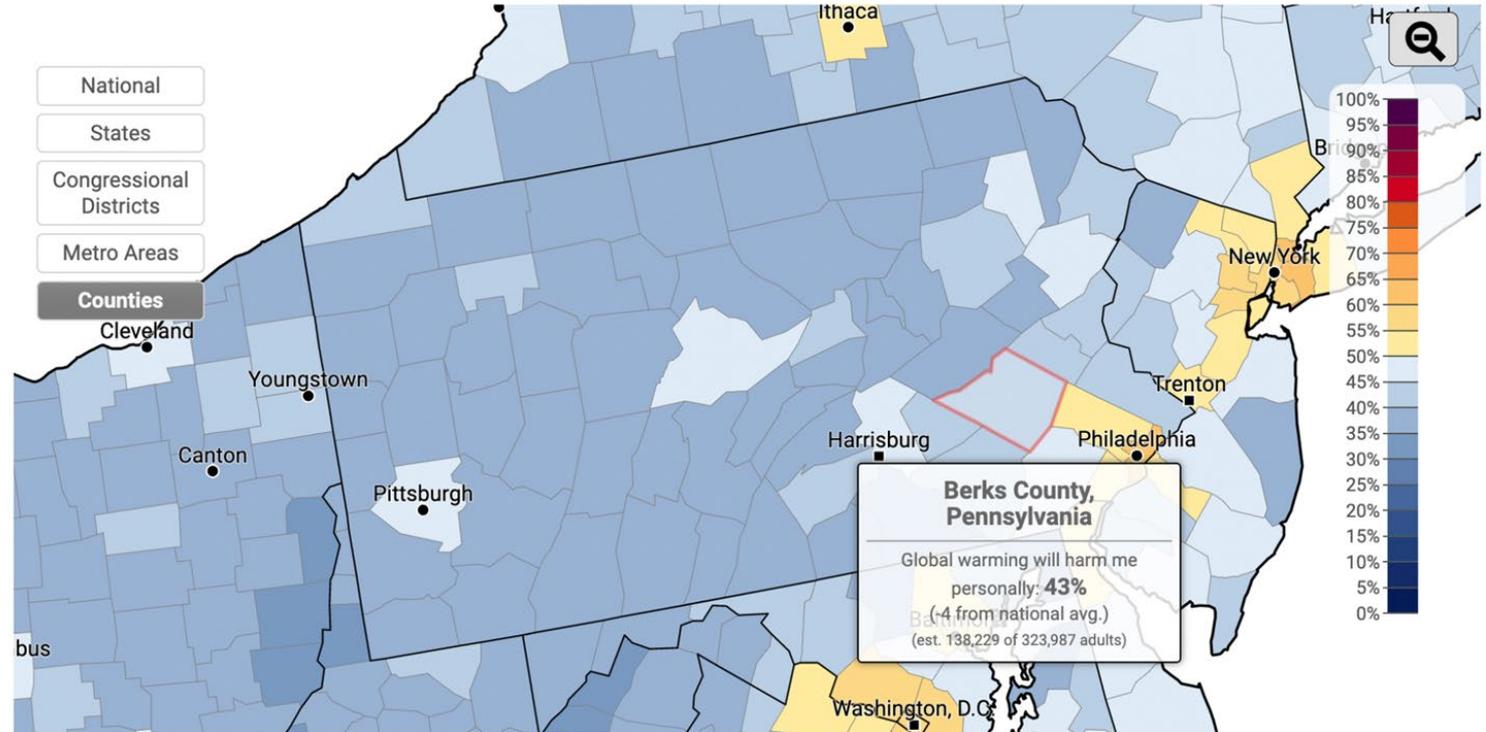
Click on map to select geography, or: Select a County



Estimated % of adults who think global warming will harm them personally (nat'l avg. 47%), 2021

Select Question: Absolute Value

Click on map to select geography, or: Select a County





The Greenhouse Effect



Energy from the sun warms Earth

Some escapes back into space

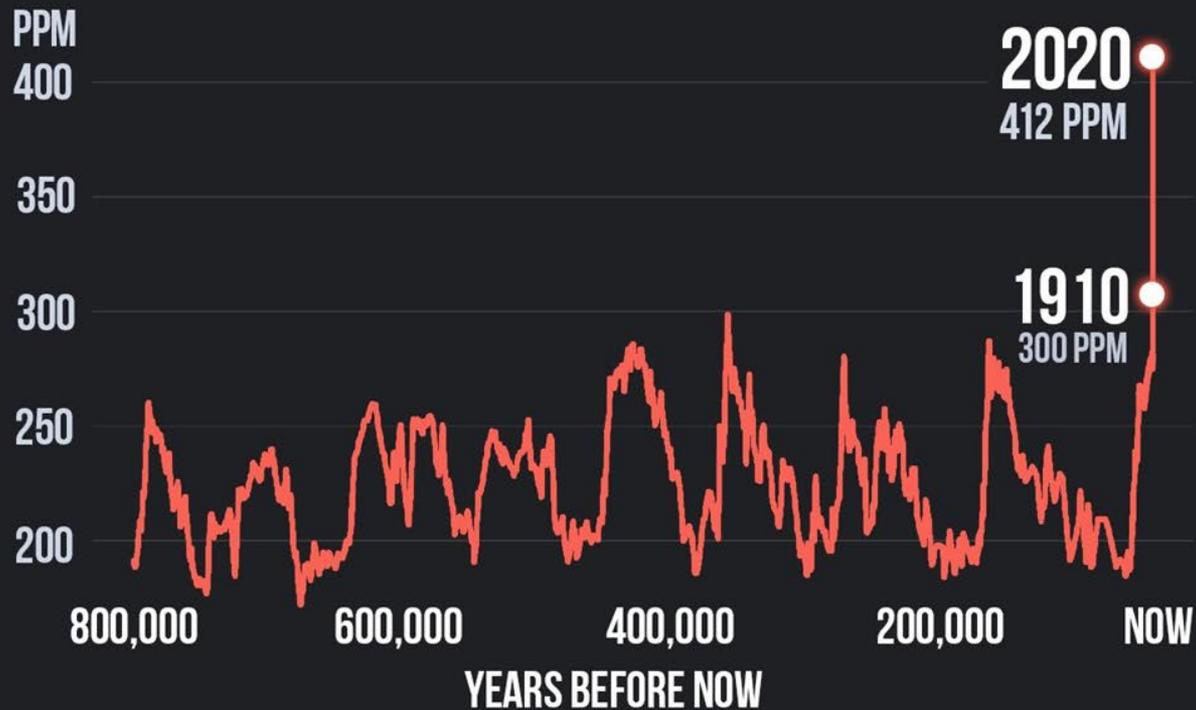
Some is held by greenhouse gases in the atmosphere

Earth is about 60°F.
Without the atmosphere it would be 0°F.



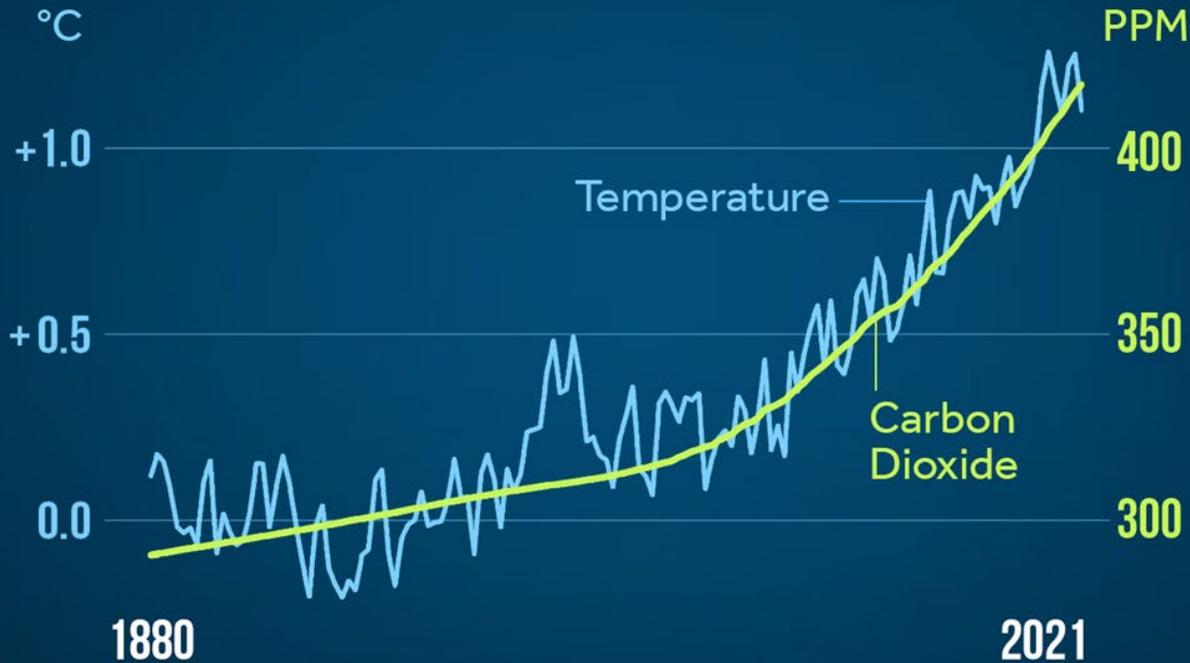
CHANGING OUR ATMOSPHERE

800,000 Years of Carbon Dioxide



Source: Luthi et al (2008) (cdiac.ornl.gov) & NOAA ESRL (esrl.noaa.gov)

TEMPERATURE & CARBON DIOXIDE



Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910)
Source: NASA GISS, NOAA NCEI, ESRL

CLIMATE  CENTRAL

METHANE CONCENTRATION

PPB

1900

1850

1800

1750

1700

1650

1983

2021

Atmospheric methane concentration
Source: US EPA

CLIMATE  CENTRAL



METHANE CONCENTRATION

PPB

1900

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1983

2021

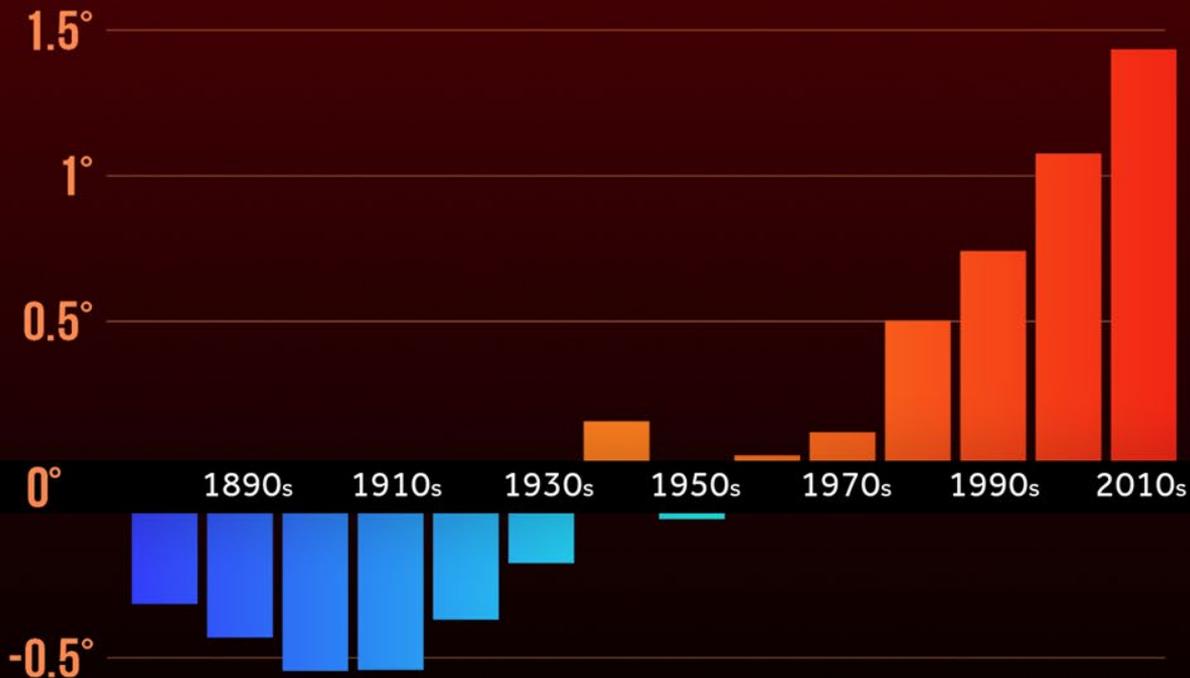


Atmospheric methane concentration
Source: US EPA

CLIMATE  CENTRAL



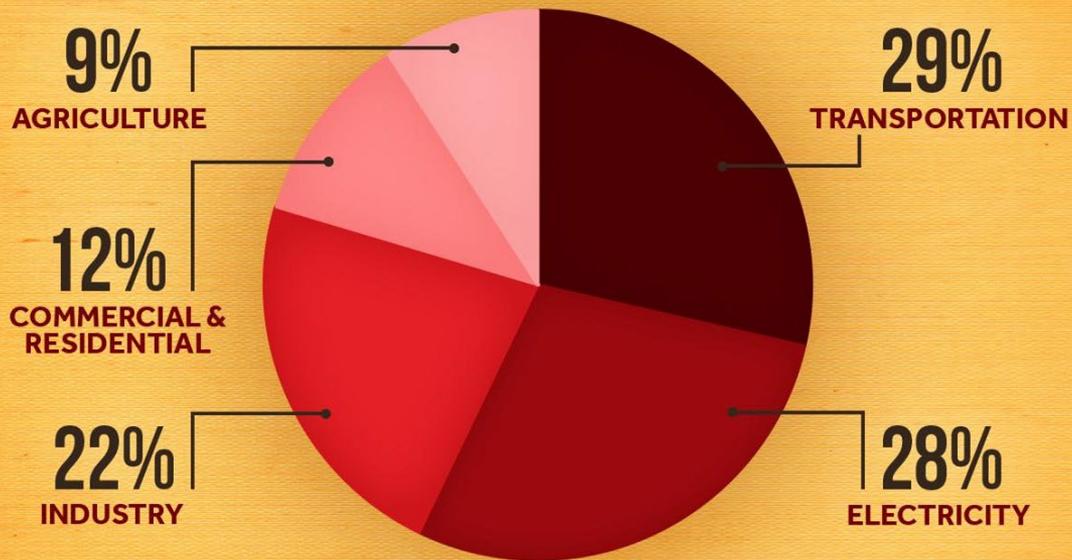
GLOBAL DECADES OF WARMING



Average decadal temperature anomalies from 20th century average (°F). Data through October 2019.
Source: NOAA

GREENHOUSE GAS SOURCES

UNITED STATES EMISSIONS BY SECTOR



Source: U.S. EPA 2017 (released 2019)

CLIMATE  CENTRAL

CLIMATE

CENTRAL

Climate Change

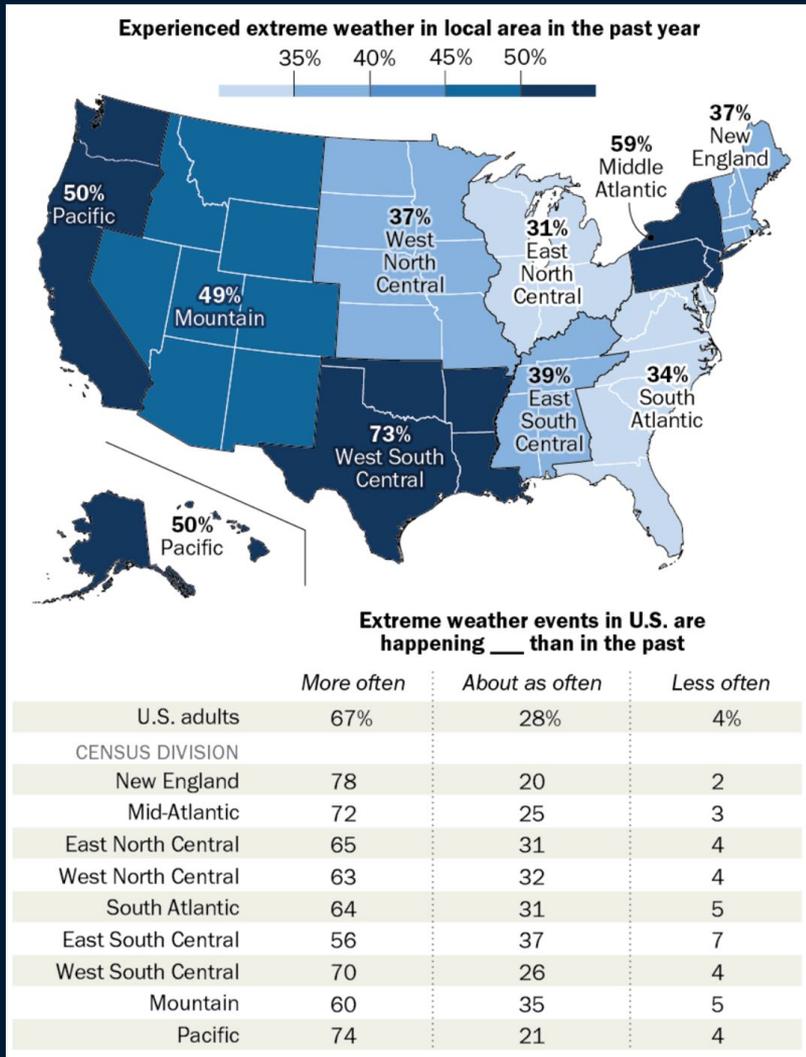
Wide-Reaching Impacts

- Weather
- Food Systems
- Water Quality
- Human Health
- Ecosystem Health
- The Economy
- Social Justice
- Infrastructure
- Energy and Transportation
- National Security
- Changing Oceans
- Shifting Seasons
- Tourism



Two-thirds of U.S. adults see extreme weather events happening more often

Pew Research Oct. 2021



Extreme Weather

More frequent & intense due to climate change

What makes a weather event ‘extreme’?

- ❑ Has a low probability of occurring at a given location (< 10%)
- ❑ Is typically of a high intensity

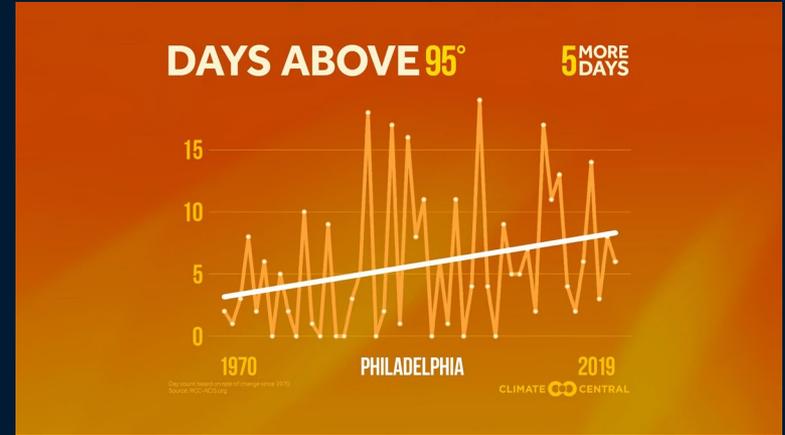
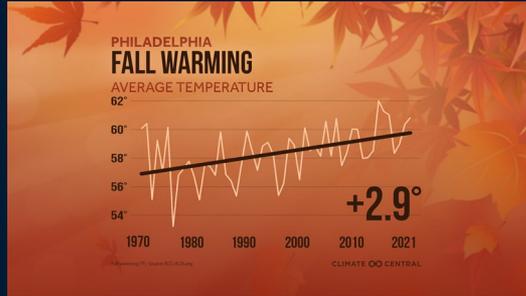
There has been a sevenfold increase in the reported disaster losses from extreme weather since the 1970s

—World Meteorological Organization (2021)



Extreme Heat

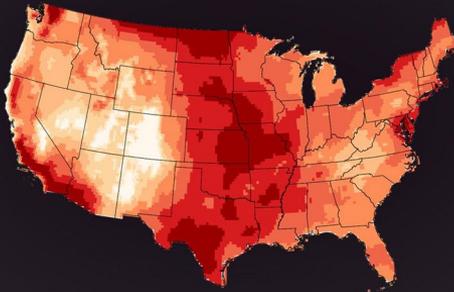
All heat metrics increasing – in all seasons



WARMING SUMMERS: HUMID HEAT

Change in summer equivalent temperature since 1950 (°F)

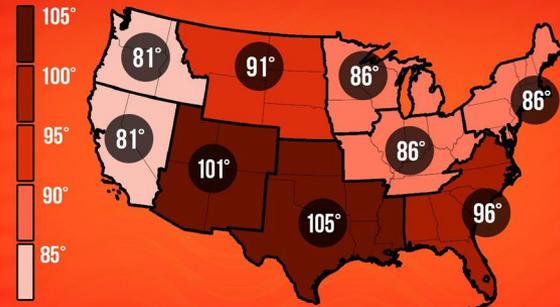
0° +1° +2° +3° +4° +5° +6° +7°



Change in average annual summer (June, July, August) equivalent temperature 1950-2021.
Source: ERA5 Reanalysis (Feriach et al., 2020), Raymond et al., 2021

HEAT & HOSPITALIZATIONS

REGIONAL HEAT INDEX RANGE FOR PEAK HOSPITALIZATIONS



Source: Vaidyanathan, et. al (2019) DOI: 10.1073/pnas.1806595116

Urban Heat Islands

Densely-developed, urban neighborhoods can run 10 °+ hotter

Extreme urban heat is a public health threat to which low income & minority communities are most vulnerable

HEAT ISLANDS

Temperature varies with land use



Source: U.S. EPA 2012

CLIMATE  CENTRAL

PHILADELPHIA HEAT ISLAND

FACTORS:

- ALBEDO
- GREENSPACE
- POPULATION DENSITY
- BUILDING HEIGHT

INTENSITY SCORE

6.3°

Source: Climate Central analysis based on Sangregrajo (2020) DOI: 10.1038/s41598-020-75018-4 and Demaree (2020) DOI: 10.1038/s41597-020-06605-z

CLIMATE  CENTRAL



CLIMATE

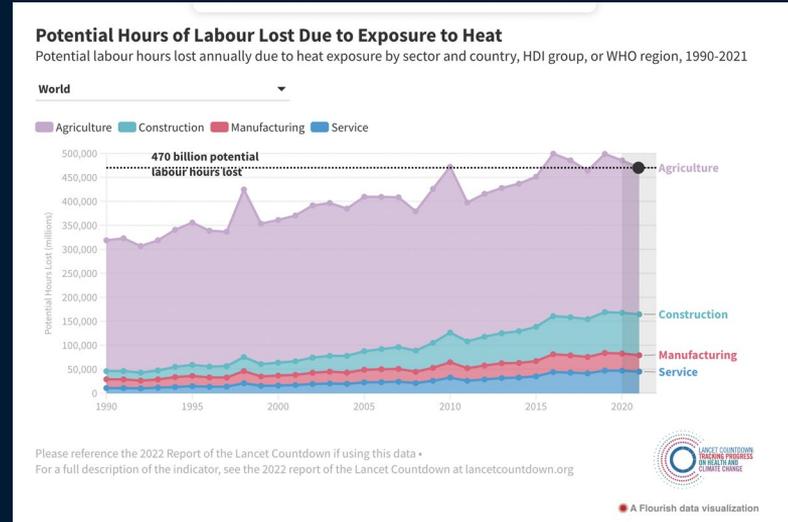
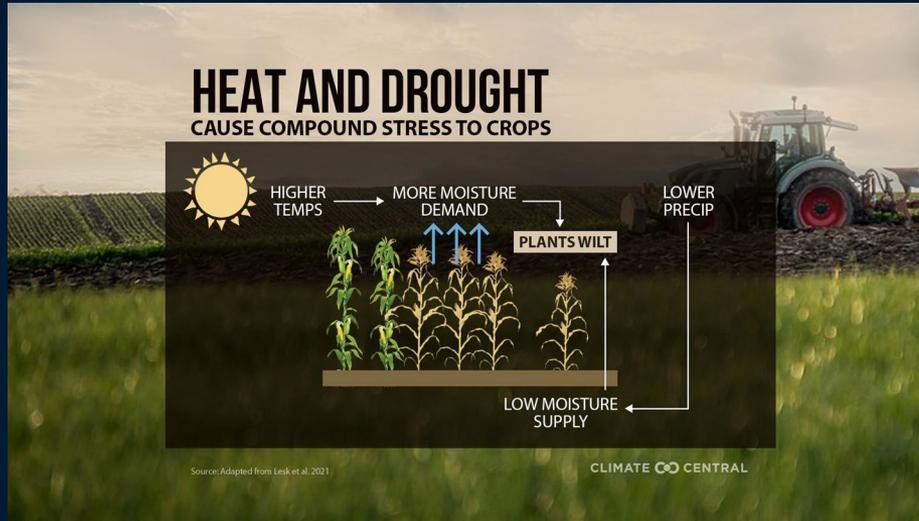
CENTRAL

Extreme Heat & Drought

Threats to Agriculture

Berks County

2nd biggest total crop producer in PA
Crops sold yield \$555M in revenue, *per 2017*
Census of Agriculture



Heat exposure alone led to 470 billion potential labour hours lost globally in 2021 in the agriculture sector

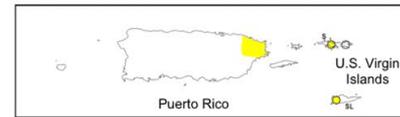
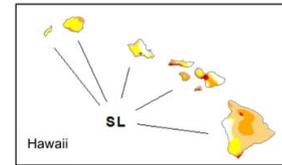
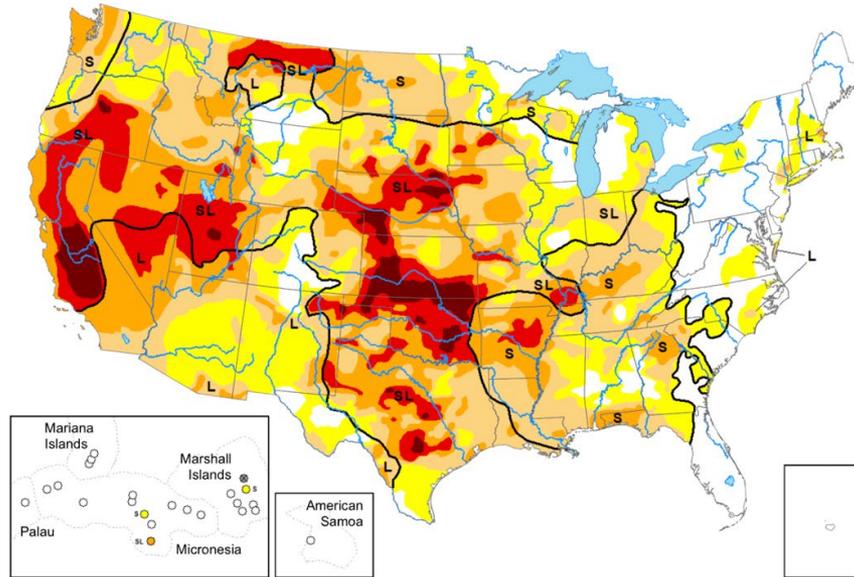
Drought

Extensive drought across much of the country



Map released: October 27, 2022

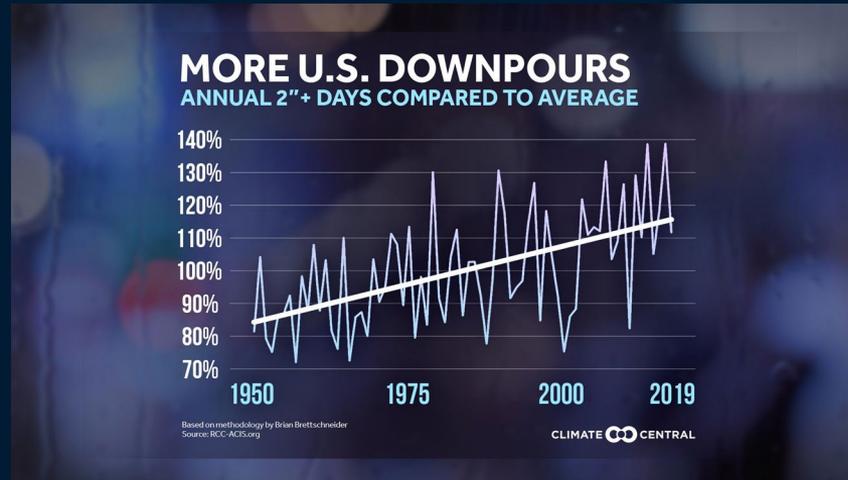
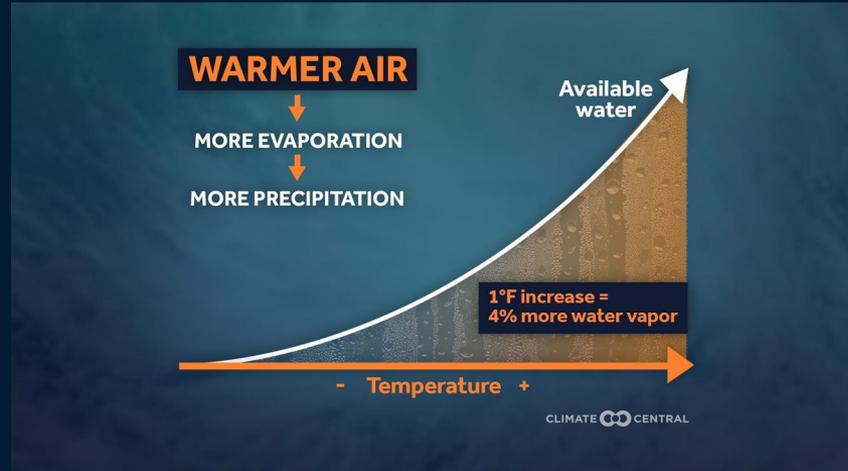
Data valid: October 25, 2022



Heavy Rainfall

More moisture = heavier rains

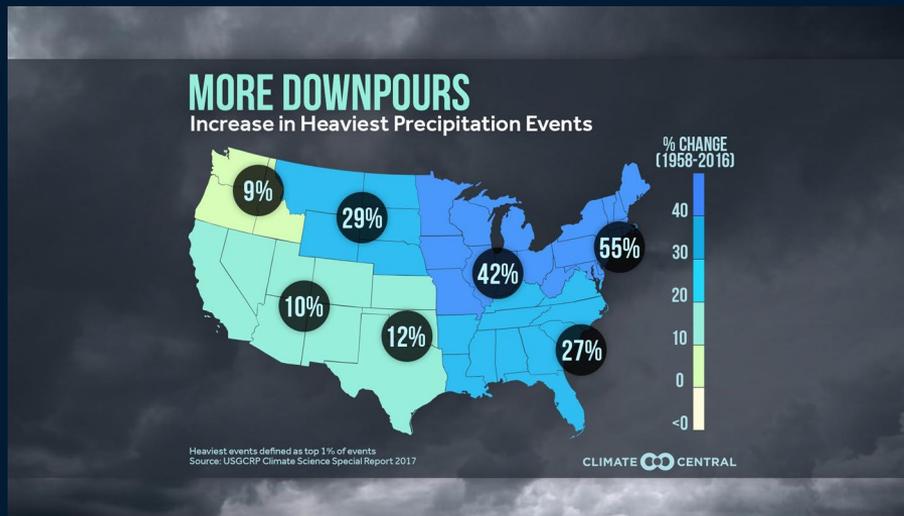
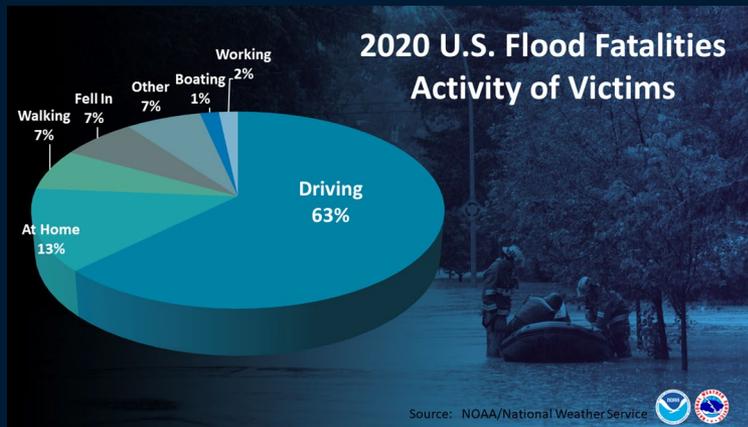
- ❑ Heavy rain events are becoming more frequent and more intense
- ❑ Impacts include crop damage, soil erosion and increased flood risk



Heavy Rainfall

Heavier rains = flashier floods

- ❑ More frequent flash flooding events, faster onset
- ❑ Reduces warning lead time and time to employ safety measures
- ❑ Greatest threat to drivers
- ❑ Vehicle submersions account for up to 10% of all drownings in high-income countries



Thunderstorms

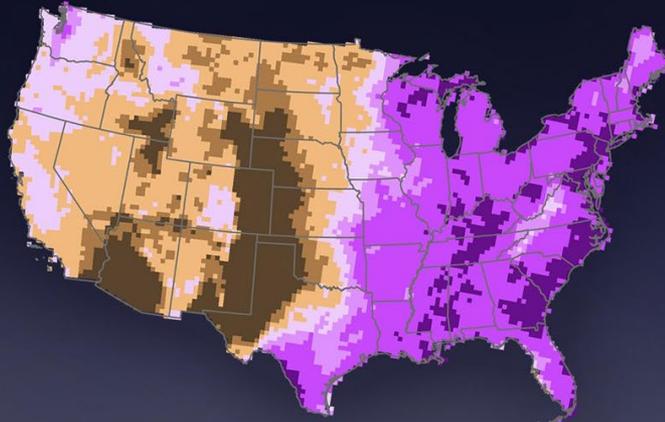
More heat = more unstable atmosphere



ANNUAL THUNDERSTORM POTENTIAL

Change in days with CAPE at or above 1000 J/kg since 1979

-40 -20 -10 -5 0 +5 +10 +20 +40



Change (from 1979 to 2021) in average number of days per year with Convective Available Potential Energy (CAPE) values greater than or equal to 1000 J/kg
Source: NCEP North American Regional Reanalysis

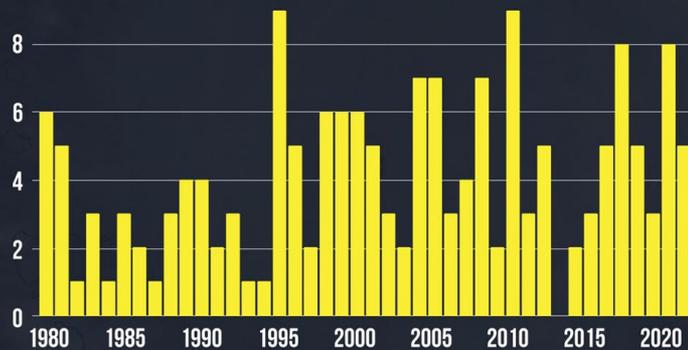
CLIMATE  CENTRAL

Strong Hurricanes

More hurricanes are rapidly intensifying

STRONGER, FASTER

Atlantic Tropical Cyclones Intensifying at least 30 kts in 24 hours

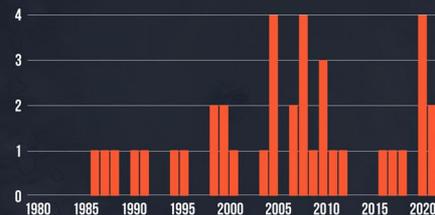


Atlantic named storms intensifying at least 30 knots in 24 hours
Source: Phil Klotzbach, Colorado State University; HURDAT 2 data

CLIMATE CENTRAL

EXTREMELY STRONGER, FASTER

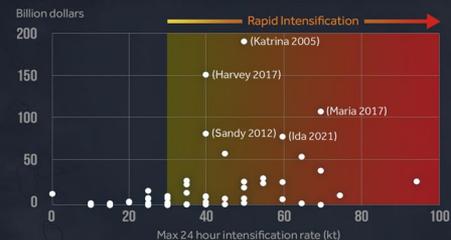
Atlantic Tropical Cyclones Intensifying at least 50 kts in 24 hours



Atlantic tropical cyclones intensifying at least 50 knots in 24 hours
Source: Phil Klotzbach, Colorado State University; HURDAT 2 data

CLIMATE CENTRAL

STRONGER STORMS, HIGHER COST



Cost and Max 24-hour Intensification Rate for Tropical Cyclones from 1980-2021
Data Source: Phil Klotzbach, Colorado State University; HURDAT 2 data

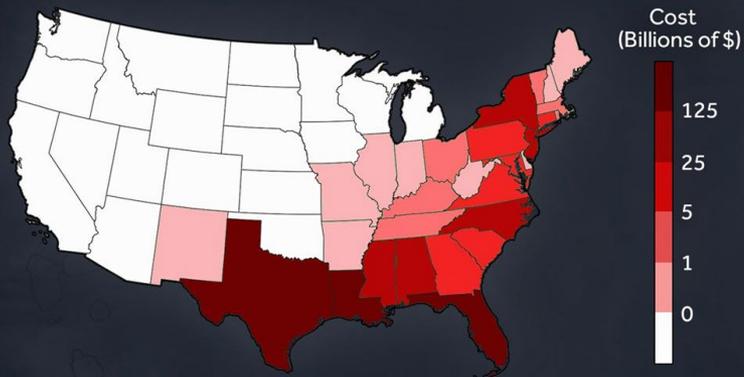
CLIMATE CENTRAL

Strong Hurricanes

Not just a coastal concern

TROPICAL CYCLONE COST

Billion-dollar tropical cyclones, 1980-2021



CPI Adjusted
Source: NOAA/NCEI

CLIMATE CENTRAL

U.S. TROPICAL CYCLONE FATALITIES 2016-18

Other

17%

83%

Water Related

Mostly inland flooding - only 4% storm surge related

2022 BILLION-DOLLAR DISASTERS

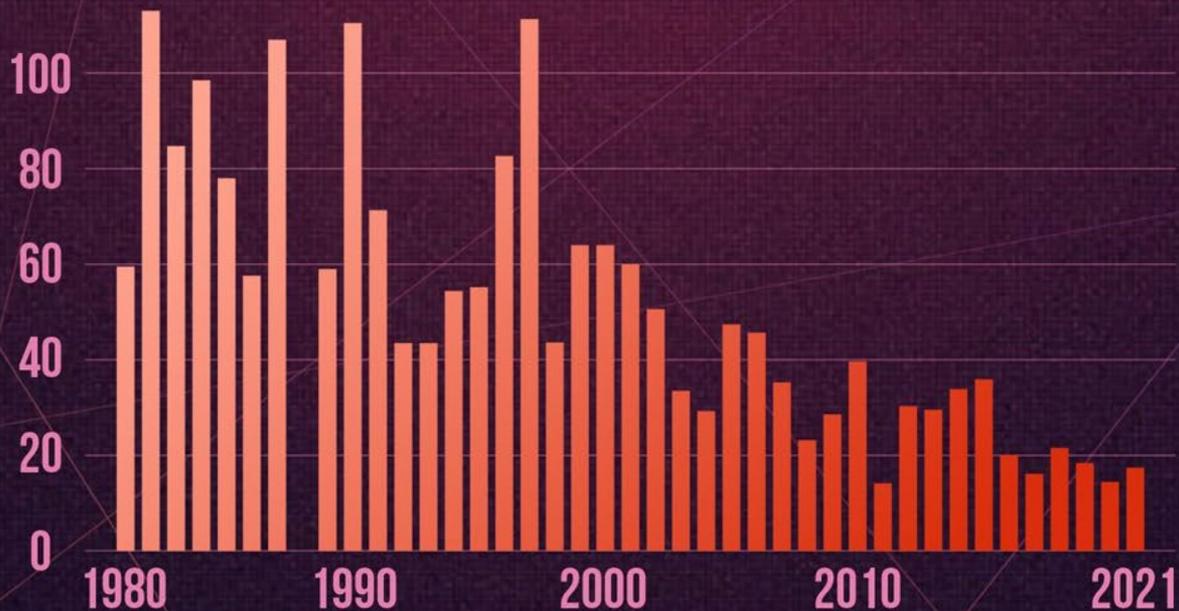
WEATHER AND CLIMATE EVENTS



Cumulative billion-dollar disaster frequency, 1980-2022 average.
Source: NOAA/NCEI

MORE FREQUENT DISASTERS

DAYS BETWEEN BILLION-DOLLAR EVENTS

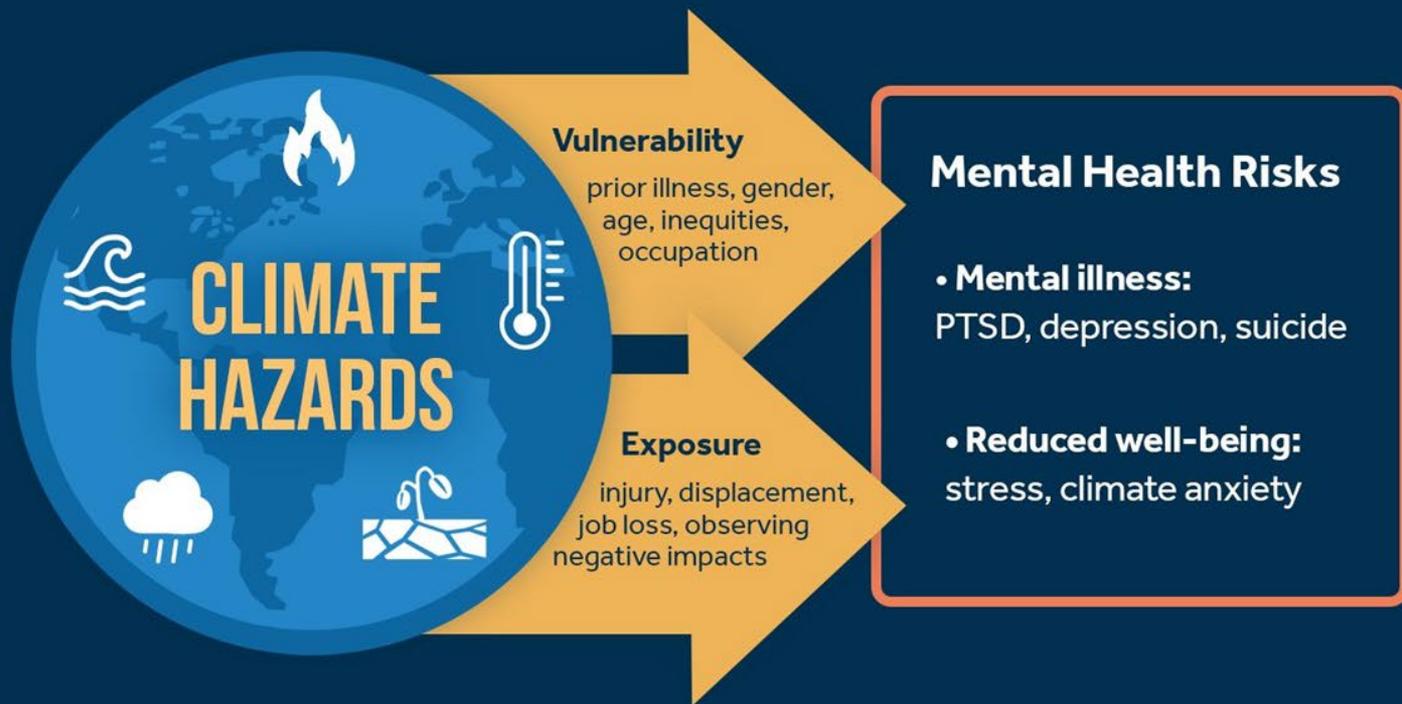


Number of days between billion-dollar disasters in a calendar year.

No disasters in 1987 and only one in 1988.

Source: NOAA/NCEI

Climate Change & Mental Health



Source: Adapted from IPCC AR6 WGII Ch 7 (2022) & [health2016.globalchange.gov](https://www.health2016.globalchange.gov) Ch 8 (2016).

Climate Solutions

For mitigation and adaptation

What We Need to Do Now:

- End dependency on fossil fuels
- Stop subsidizing fossil fuel sources, companies & infrastructure
- Invest in climate solutions (safe bikeways, expanded green spaces...)
- All countries must act together



The Inflation Reduction Act (IRA) is projected to get the nation ~42% below 2005 levels CO₂ by 2030

PENNSYLVANIA

Climate Friendly Homes Can Save:

Utility costs:

\$787 per year

Emissions reductions:

3.3 tons of CO₂ equivalent per year



Savings per household
Source: Wilson et al. 2017

CLIMATE  CENTRAL

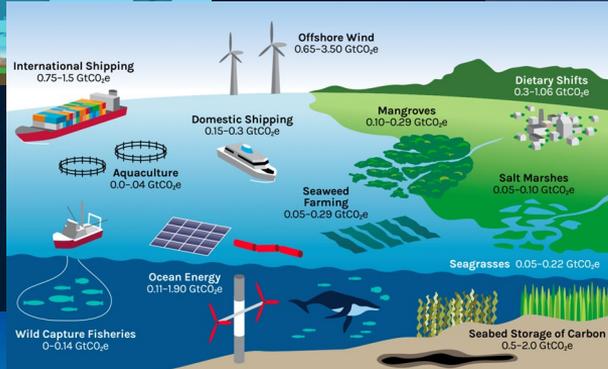
Carbon Capture, Utilization, and Storage



BERKS COUNTY SOLAR ELECTRICITY GENERATION

	TODAY
EQUIVALENT HOMES POWERED	5,180
CAR MILES	119,000
SMARTPHONES CHARGED	13.1 million

Equivalent homes powered by solar electricity generated, based on the number of homes in the area, assuming average solar panel capacity. Car miles charged, the number of miles a car would have to be driven to emit the same amount of CO2 as the solar electricity generated. Smartphones charged, the number of typical smartphones that can be charged using the amount of solar electricity generated. Source: Climate Central's solar power tool.



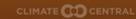
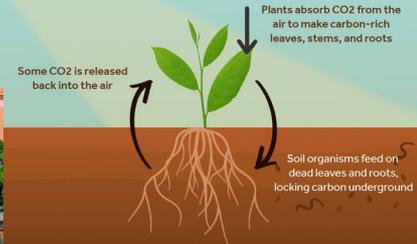
PENNSYLVANIA WIND ELECTRICITY GENERATION

	TOMORROW
CO2 AVOIDED (TONS)	2,890
EQUIVALENT HOMES POWERED	307,000
TREES PLANTED	48,200

Equivalent homes powered by wind electricity generated, based on the number of homes in the area, assuming average solar panel capacity. Car miles charged, the number of miles a car would have to be driven to emit the same amount of CO2 as the solar electricity generated. Smartphones charged, the number of typical smartphones that can be charged using the amount of solar electricity generated. Source: Climate Central's solar power tool.



HOW SOIL STORES CARBON



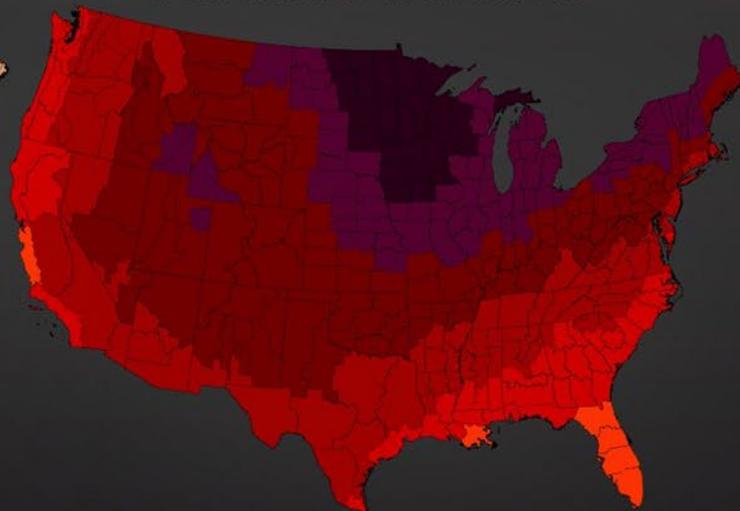
WARMING BY 2100



SIGNIFICANT CUTS



CONTINUED EMISSIONS



Projections of change in annual average temperature relative to the 1991-2020 normal under significant emissions cuts (SSP1-2.6) and continued emissions (SSP3-7.0).
Source: CMIP6

Resources

My email: lcasey@climatecentral.org

EPA Climate Change Indicators:

<https://www.epa.gov/climate-indicators>

Yale Program on Climate Change
Communication:

<https://climatecommunication.yale.edu/>

UN – Climate Action:

<https://www.un.org/en/climatechange>

NASA: Global Climate Change:

<https://climate.nasa.gov/>

