



# Climate Change and SARS-CoV-2

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Jan. 8, 2020

## 'Armageddon Is Here': Australian Readers Share Their Wildfire Experiences

Sept. 12, 2019

CLIMATE

## Extreme Weather Displaced a Record 7 Million in First Half of 2019

Oct. 29, 2019

CLIMATE

## Rising Seas Will Erase More Cities by 2050, New Research Shows

Jan. 2, 2020

## Apocalypse Becomes the New Normal

We're already in the early stages of climate crisis.

By PAUL KRUGMAN

# Climate-Health Emergency

**220 million  
additional exposures  
to heatwaves among  
people 65 and up in  
2018**



**821 million people  
undernourished  
partly due to  
drought**



**7 million climate  
refugees in the first  
half of 2019**



**Suitability for  
disease transmission  
increased for  
dengue, malaria,  
cholera, and others**



# Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)

## Worldwide

3.85 M cases

>269 K deaths

## United States

1.25 M cases

>75 K deaths



# Unraveling the Relationship between SARS-CoV-2 and Climate Change

1. Emergence and/or spread of SARS-CoV-2
2. Development of severe COVID-19 illness
3. Pandemic impact on climate change and climate response
4. Lessons for climate change action from the pandemic response

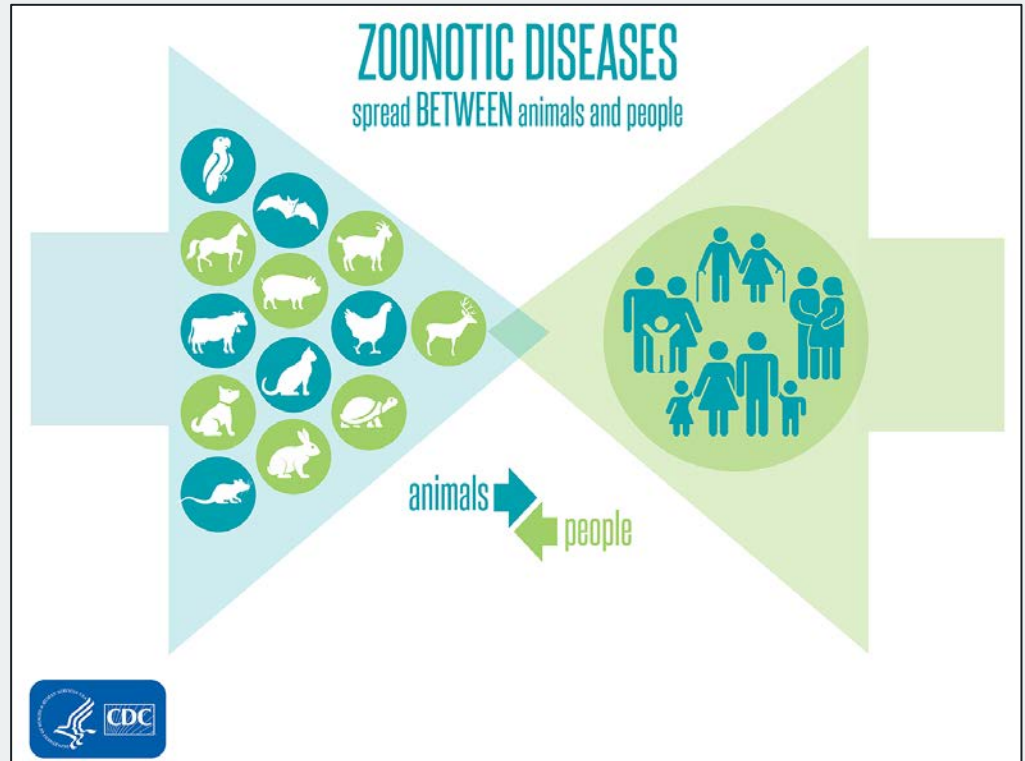
# SARS-CoV-2 is a Zoonotic Disease

**Direct contact** with animal body fluids

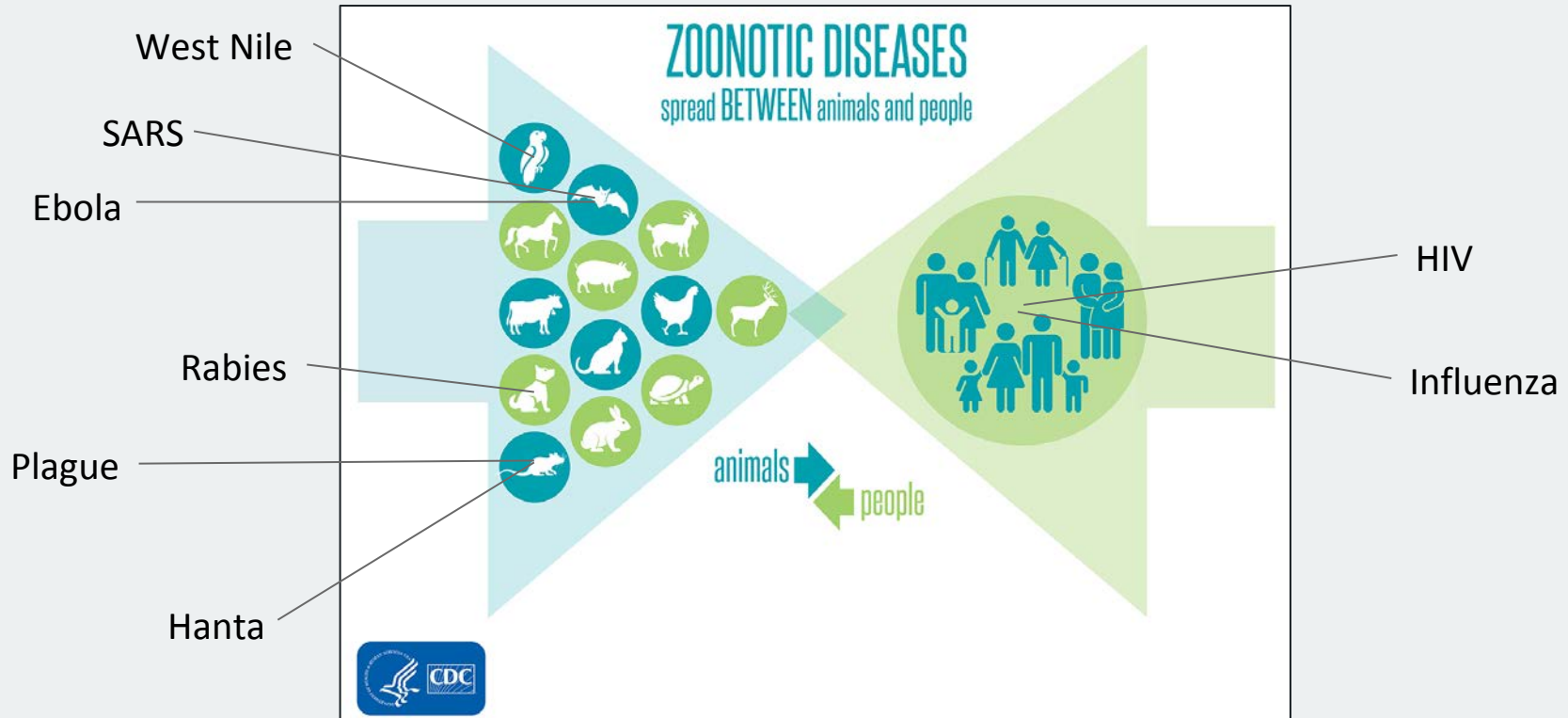
**Indirect contact** where animals live or roam

**Vector-borne** from ticks or insects

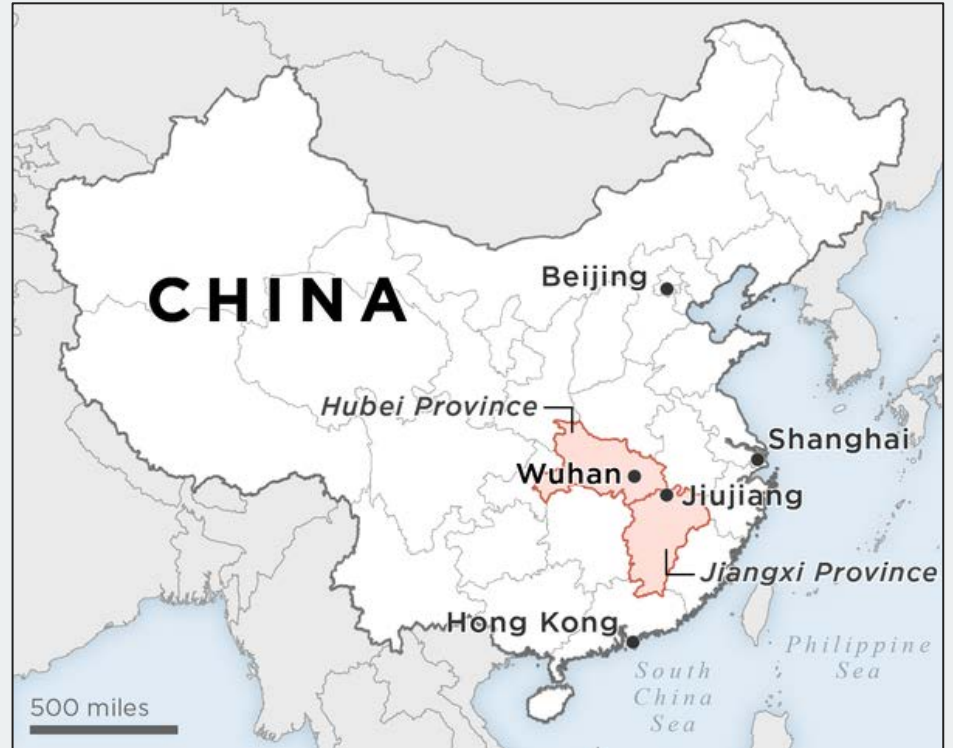
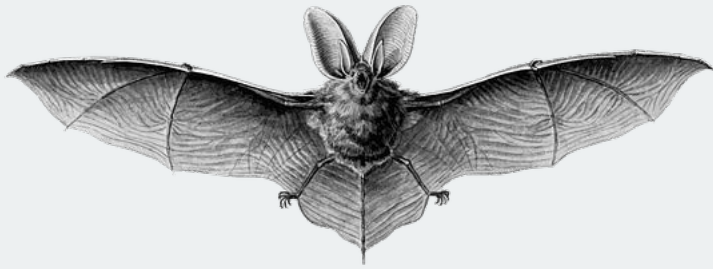
**Foodborne or waterborne** via contaminated food or water



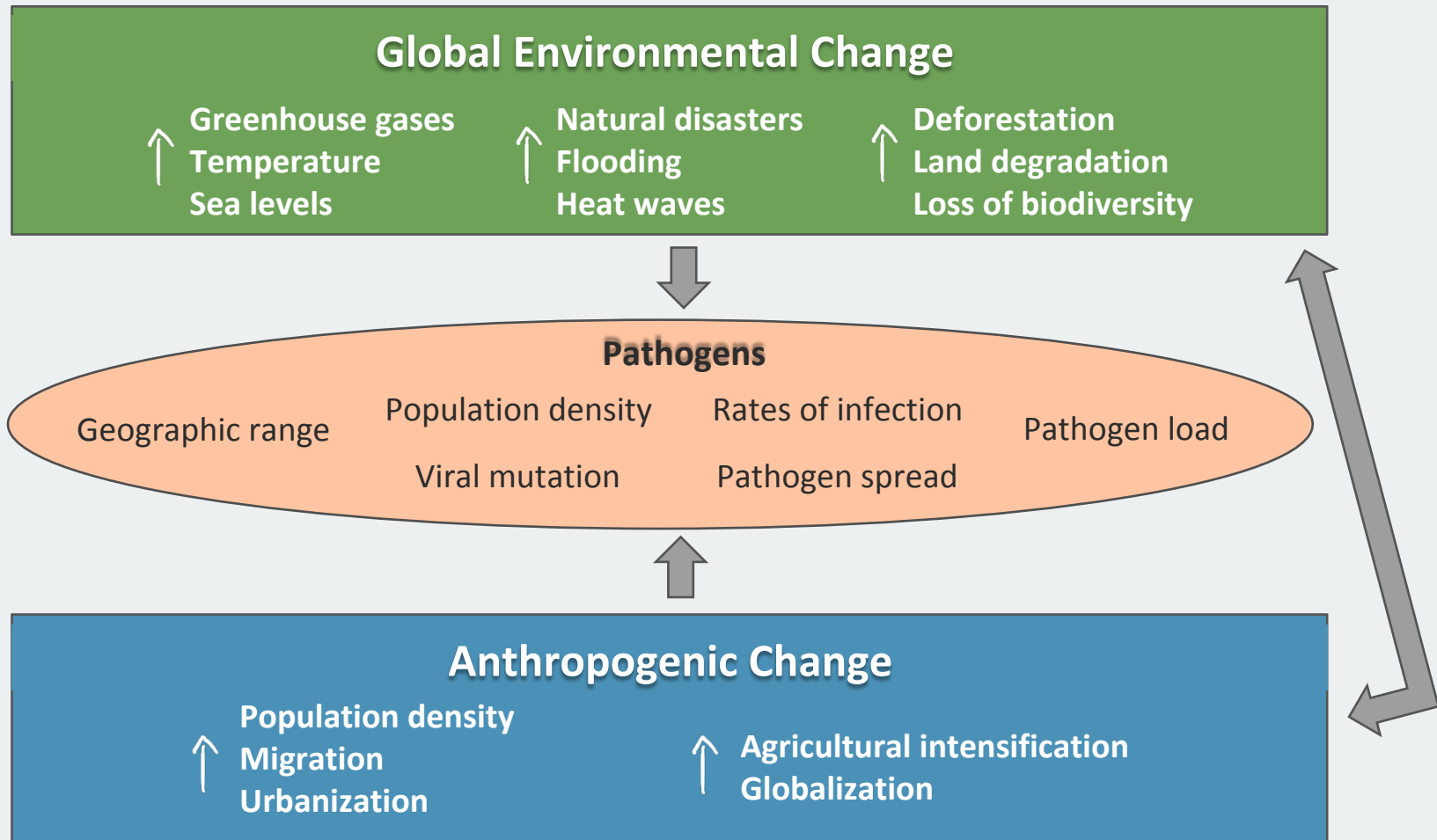
# SARS-CoV-2 is a Zoonotic Disease

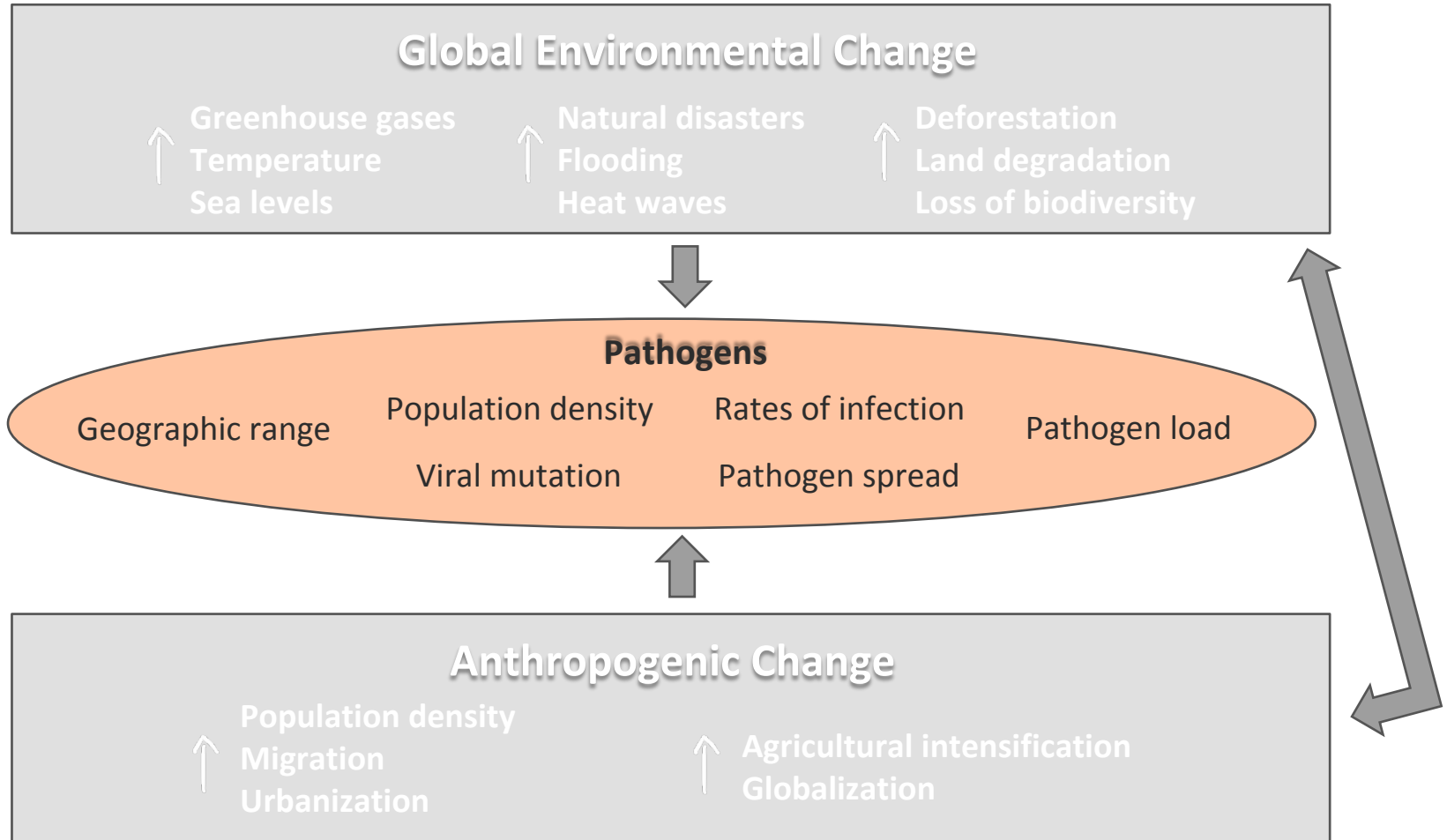


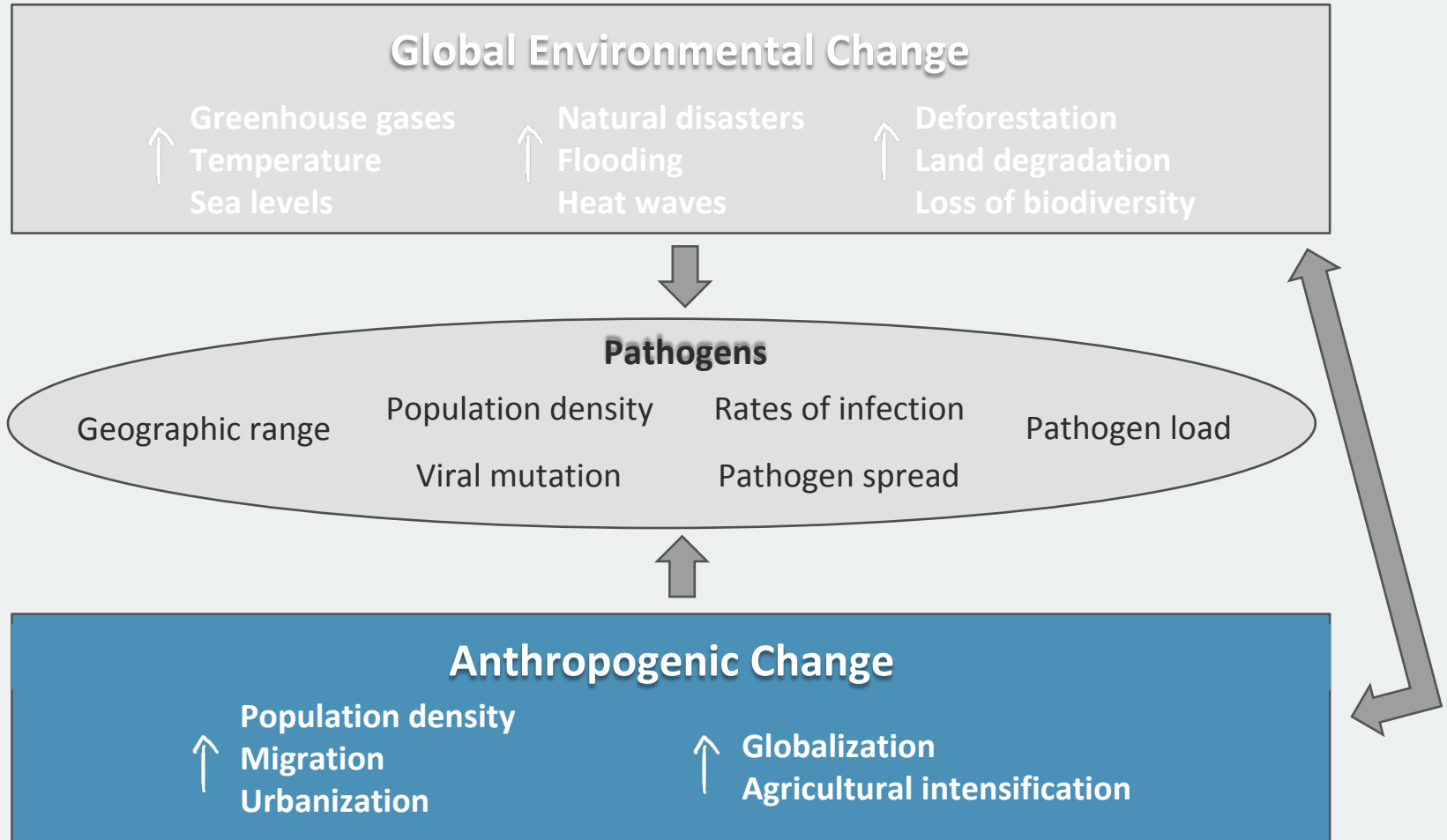
# The Emergence of SARS-CoV-2







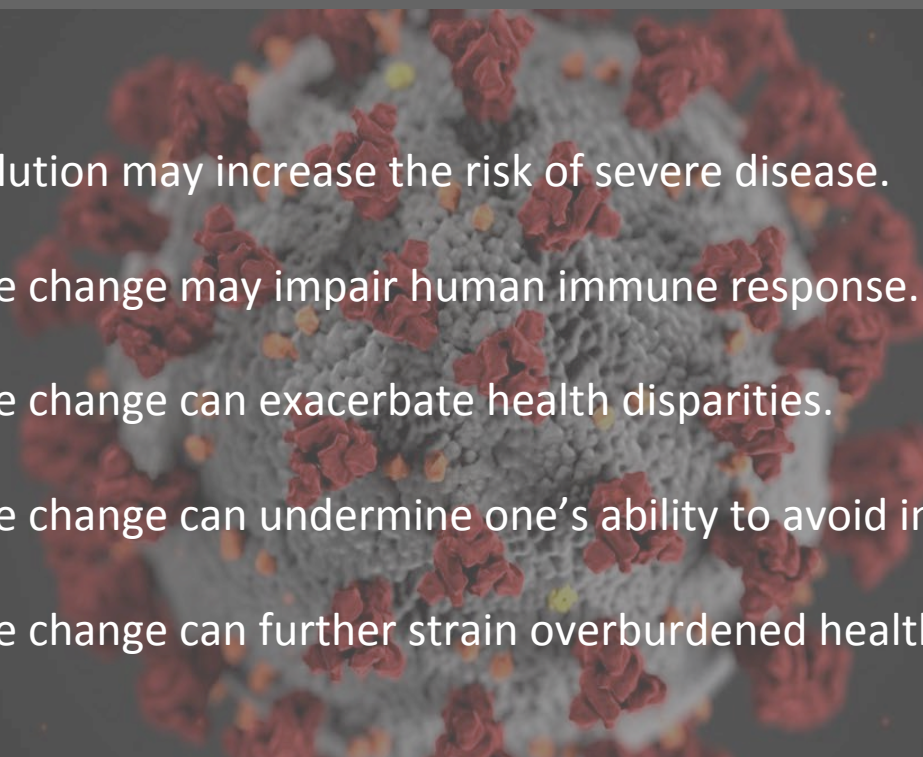




A man and a child are walking away from the camera on a rocky shoreline at sunset. The man is wearing a light-colored shirt and dark pants, and the child is wearing a green jacket and pink pants. They are holding hands. The water is calm, and the sun is low on the horizon, creating a warm glow and lens flare. In the background, a long bridge with many pillars spans across the water. The sky is clear and blue.

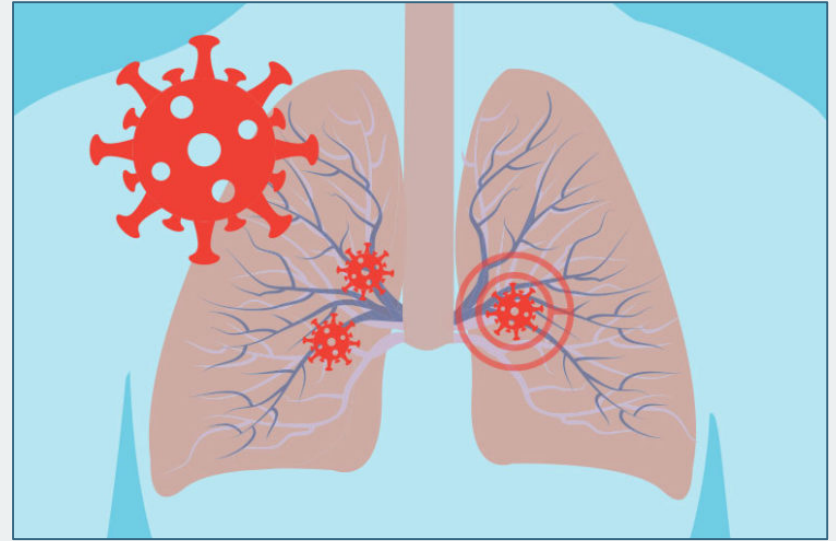
Both the pandemic and climate crisis underscore that **planetary and human wellbeing are inextricably linked.**

# Climate Change and COVID-19

- 
1. Air pollution may increase the risk of severe disease.
  2. Climate change may impair human immune response.
  3. Climate change can exacerbate health disparities.
  4. Climate change can undermine one's ability to avoid infection.
  5. Climate change can further strain overburdened healthcare systems.

# Air Pollution and COVID-19

- Air pollution results in acute airway inflammation, decreases in lung function and has been associated with ARDS and cardiovascular disease mortality<sup>1</sup>
- Fossil fuel pollutants suppress the immune system and enhance allergic reactions<sup>2</sup>
- Underlying lung or heart disease may increase risk of severe illness from COVID-19
- Air pollution was associated with SARS morbidity and mortality<sup>3</sup>



*Cleveland Clinic*

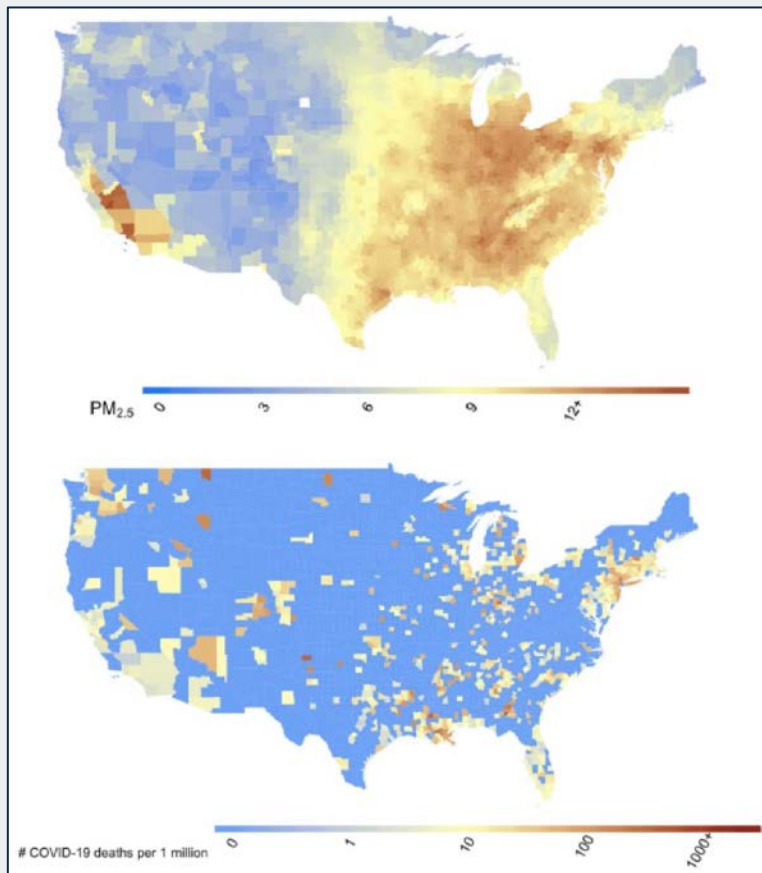
1. Rhee, Chest, 2019; Brook Circulation 2010; Barraaza-Villarreal Environ Health Perspectives 2008; 2. Nadeau J Allergy Clin Immunol 2010; Glencross Free Radic Biol Med 2020; 3. Cui Env Health 2003.

# Air Pollution and COVID-19

Estimated MRR for  
 $PM_{2.5}$

1.08

(95% CI: 1.02, 1.15)



17-year avg of pollution ( $PM_{2.5}$ ) at  
county level (2000-2016)

Lower pollution  $\leftrightarrow$  Higher pollution

# COVID-19 deaths per 1M population  
up to April 4, 2020

Fewer deaths  $\leftrightarrow$  More deaths

# Air Pollution and COVID-19



ELSEVIER

Environmental Pollution

Volume 261, June 2020, 114465

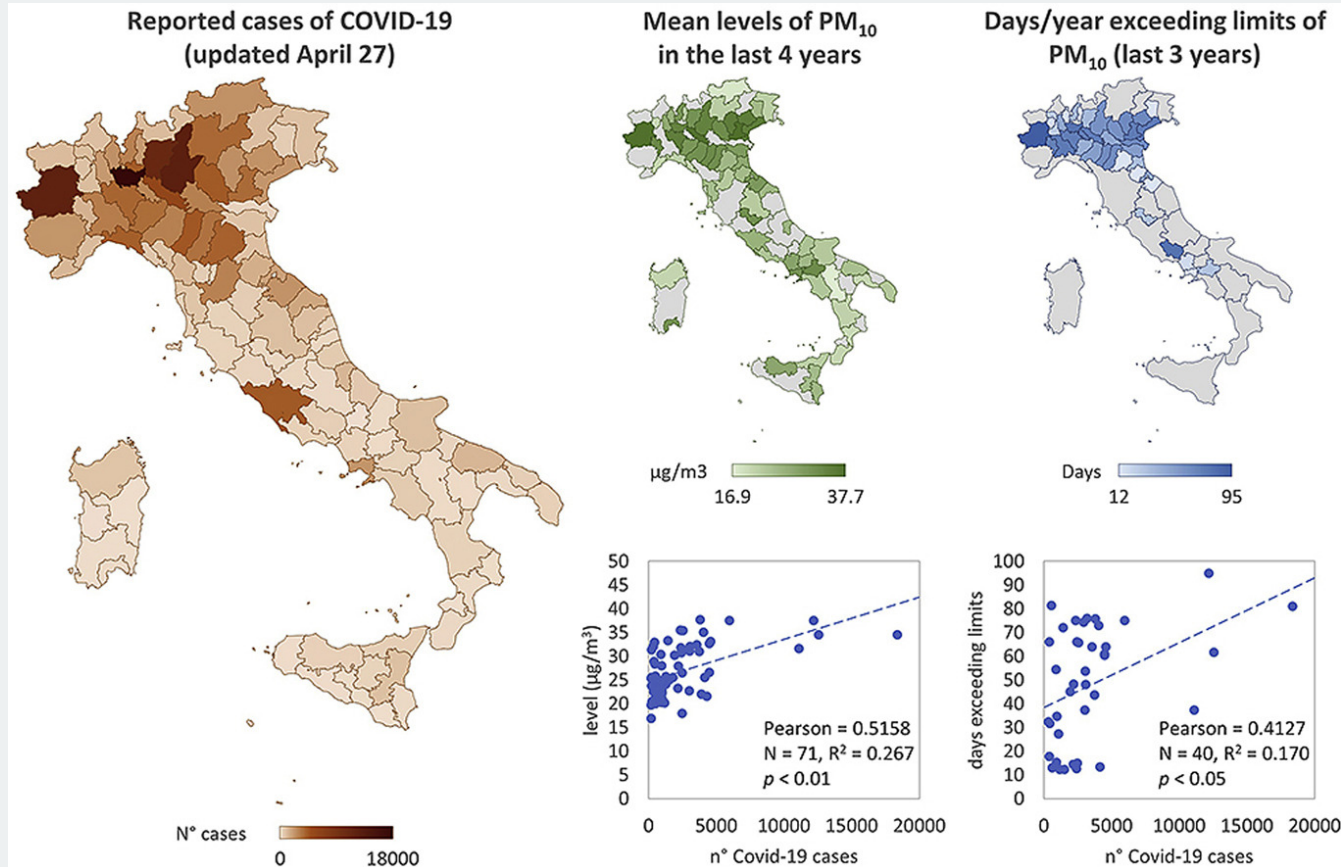


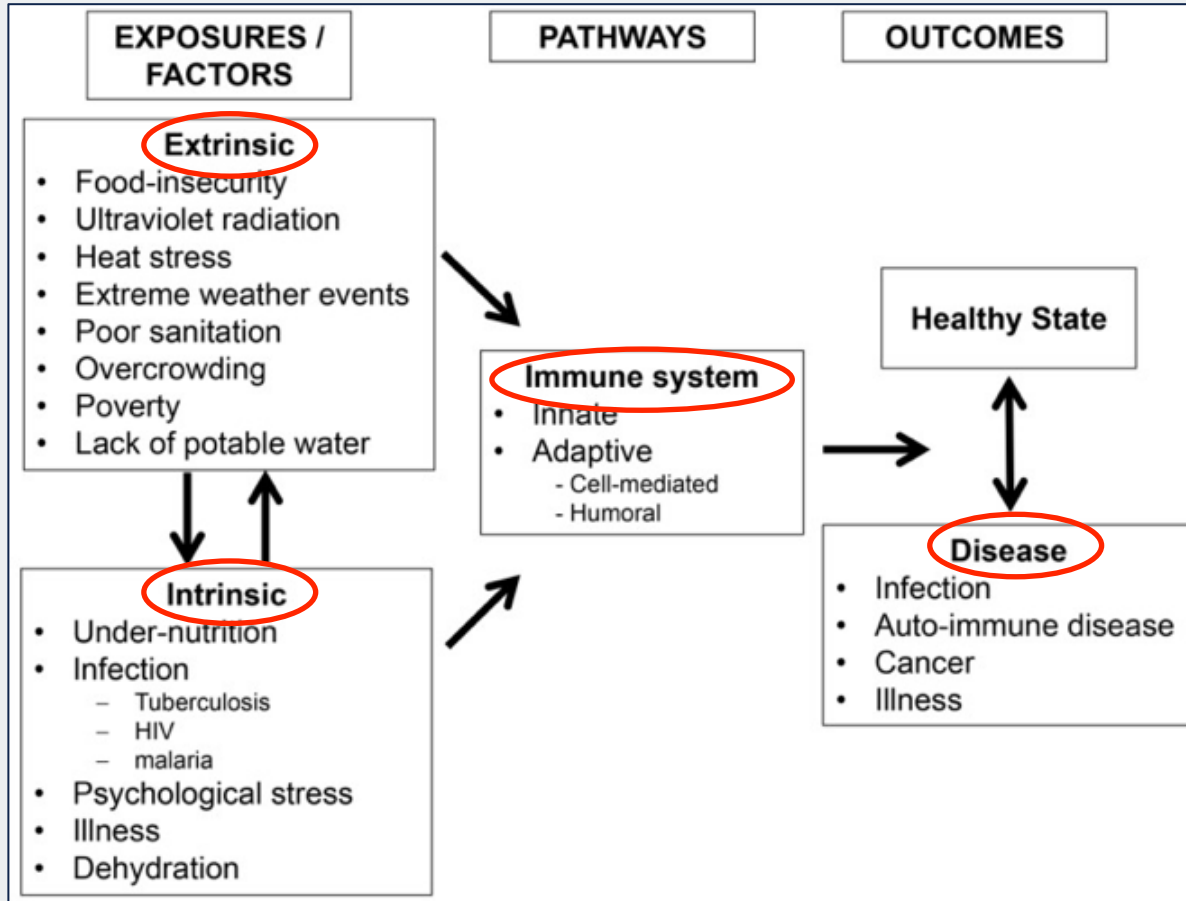
Can atmospheric pollution be considered a co-factor in extremely high level of SARS-CoV-2 lethality in Northern Italy? ☆

Edoardo Conticini <sup>a</sup>, Bruno Frediani <sup>a</sup>, Dario Caro <sup>b</sup>  



# Air Pollution and COVID-19





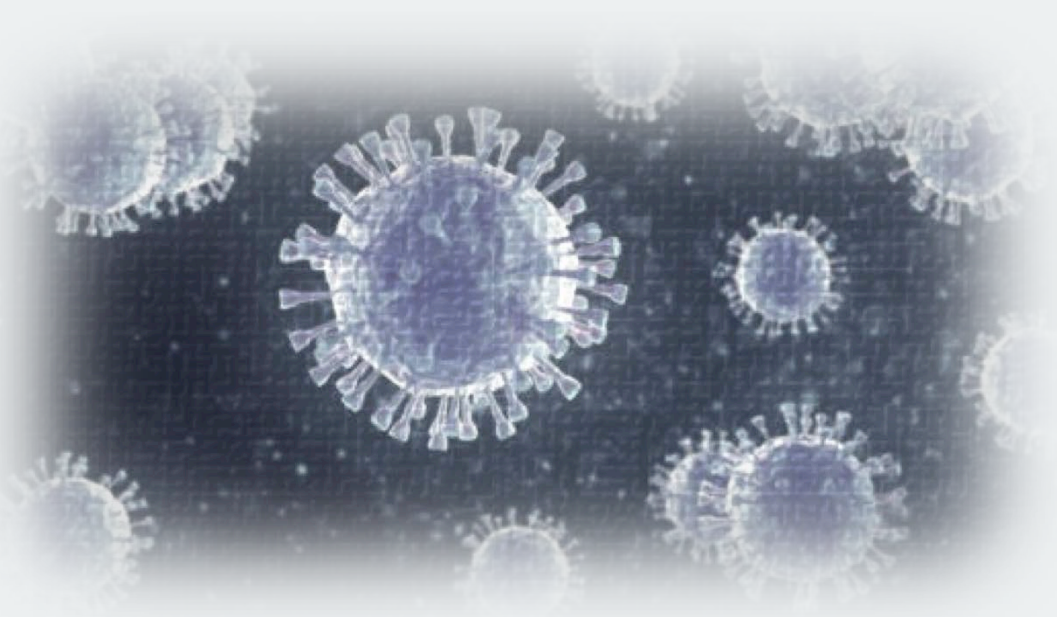
# COVID-19 Racial Disparities

Disproportionate number of COVID-19 cases and deaths among African Americans relative to population share in many US states.

Analysis of 131 predominantly black versus white US counties:

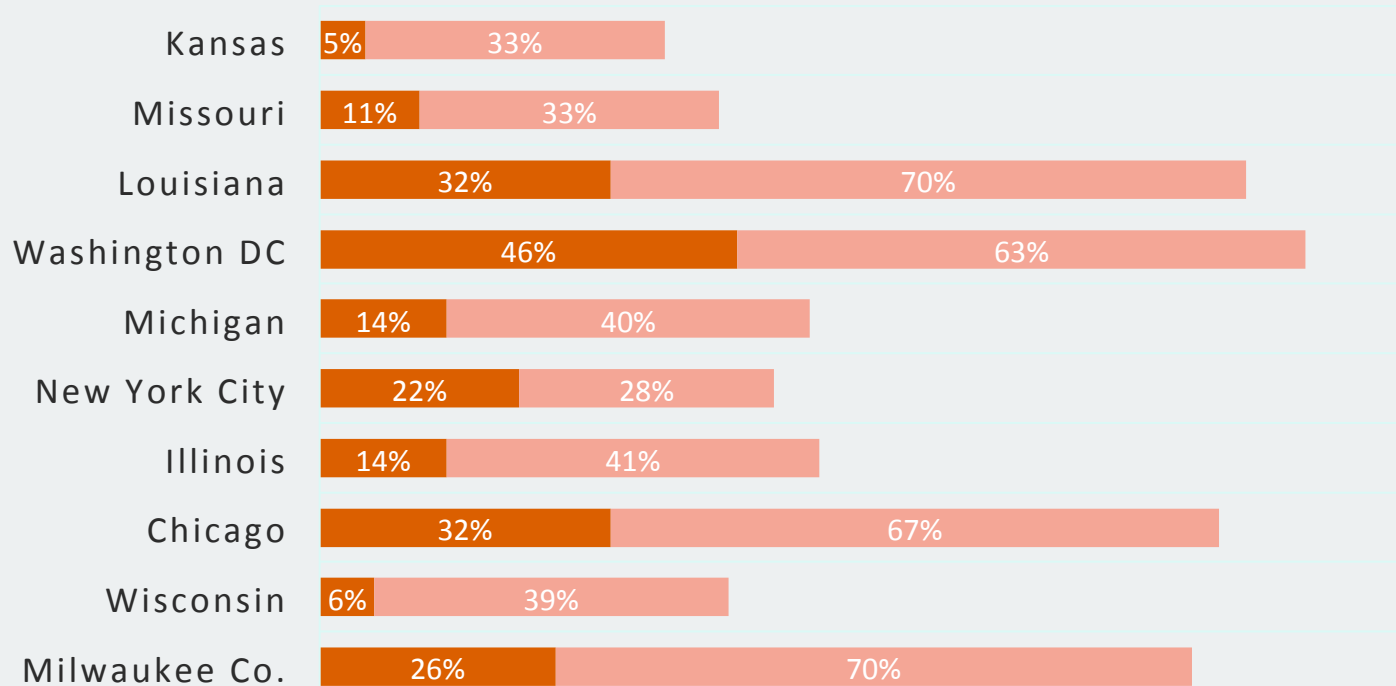
- Infection rate – 137.5/100,000  
More than 3-fold higher
- Death rate – 6.3/100,000  
6-fold higher

Disparities also seen with Hispanic, Native American, and other minority populations.



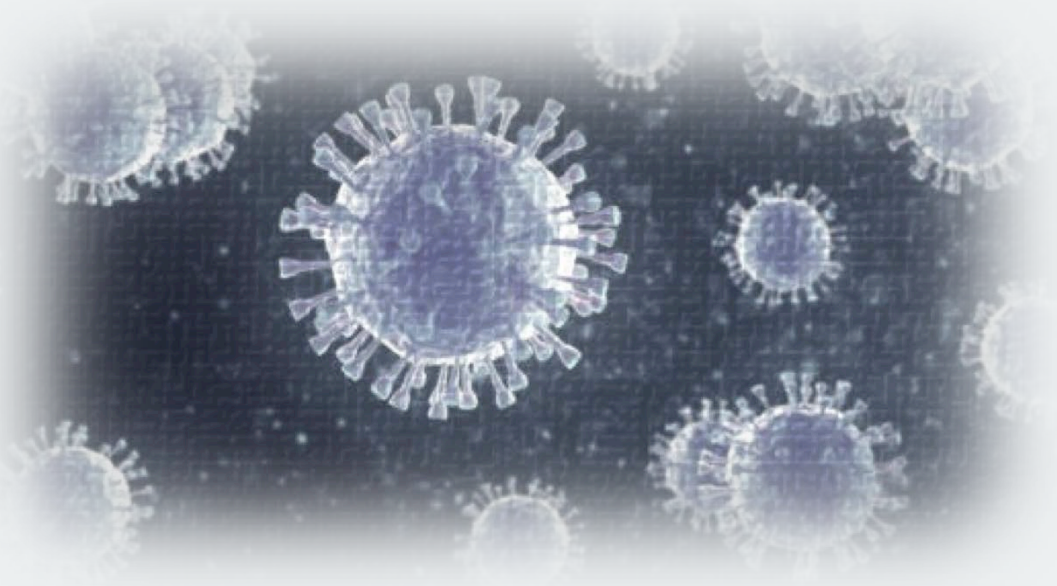
# COVID-19 Mortality Disparities among African Americans

■ % Total Population ■ % COVID-19 Deaths



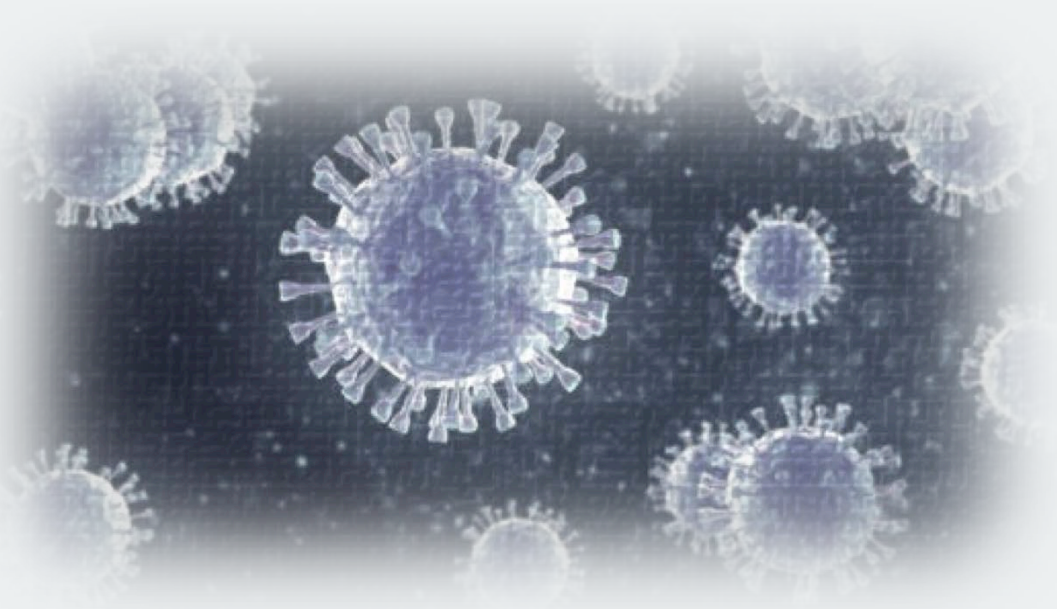
# COVID-19 Racial Disparities

- Many factors that could contribute to unequal COVID-19 burden among racial minorities (e.g., higher co-morbidities, poverty, less access to healthcare).
- Bear the brunt of environmental injustice (referred to as “the climate gap”) including:
  - Extreme weather events (e.g., Hurricane Katrina)
  - Heat waves
  - Air pollution



# COVID-19 Racial Disparities

- Unequal exposure to air pollutants:
  - ↓○ Non-Hispanic whites are exposed to **17% LESS** air pollution than caused by consumption
  - ↑○ Blacks have **56% EXCESS** exposure to air pollution relative to their consumption
  - ↑○ Hispanics have **63% EXCESS** exposure



# Climate Change and COVID-19

Climate change can undermine one's ability to avoid infection.

- a) Drought can lead to water scarcity, which make hand washing and sanitation challenging.
- b) Migration due to extreme weather events or changing climate conditions can lead to overcrowding that encourages the rapid spread of disease.
- c) Overcrowding makes social distancing and quarantine measures difficult or impossible to implement.

# Climate Change Can Strain Overburdened Healthcare Systems

Examples of climate-related health problems:

- Injuries from extreme weather events
- Heat stress leading to dehydration
- Lung disease or asthma attacks from air pollution



# Pandemic Impact on Climate Change

## Short-Term

- ↓ CO<sub>2</sub> emissions
- ↓ Energy consumption

Due to economic shutdowns, teleworking, and shelter-at-home orders

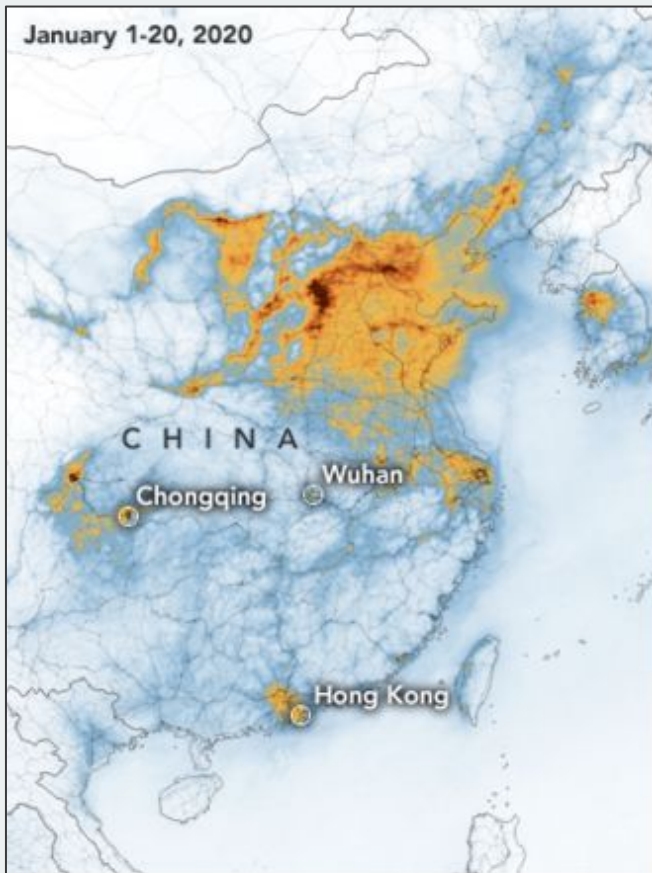
## Long-Term (?)

- ↑ CO<sub>2</sub> emissions when economies reopen
- ↓ Climate action – policy, advocacy, meetings, investment

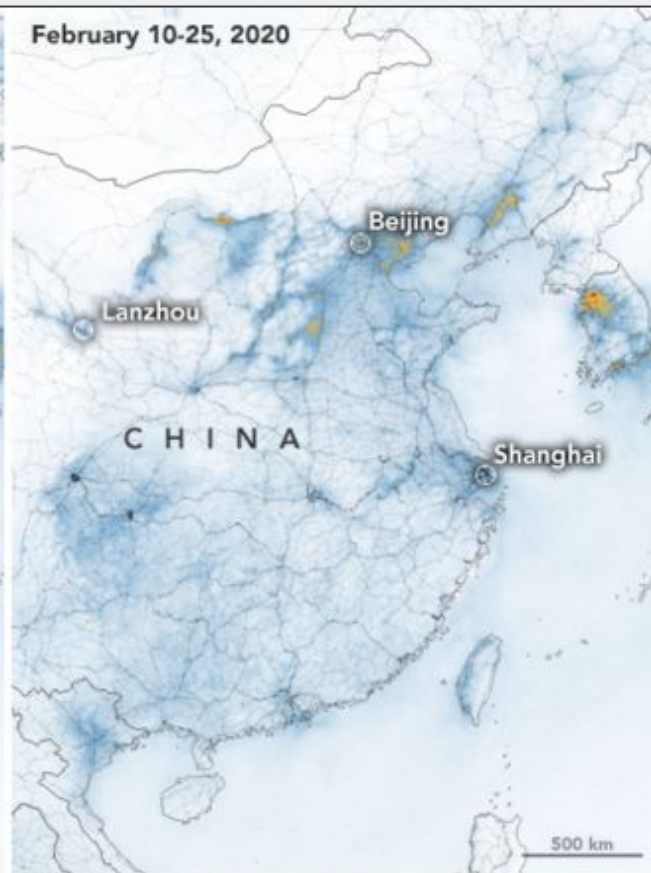
# Pandemic Impact on Climate Change

- Estimated that CO<sub>2</sub> Emissions could fall by 5.5 % from 2019 levels, largest ever annual decrease
- For comparison, emissions fell by 1.4% following the 2008 financial crash

January 1-20, 2020



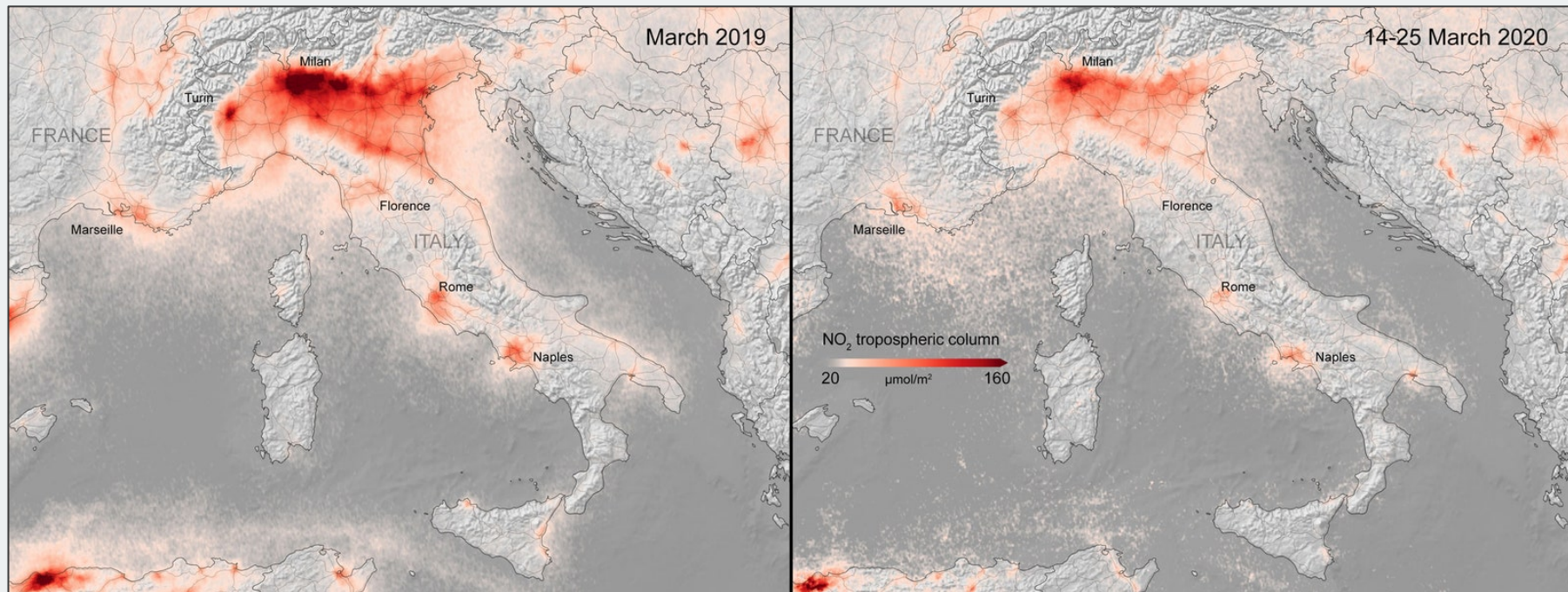
February 10-25, 2020



Mean Tropospheric NO<sub>2</sub> Density ( $\mu\text{mol}/\text{m}^2$ )

0 125 250 375  $\geq 500$

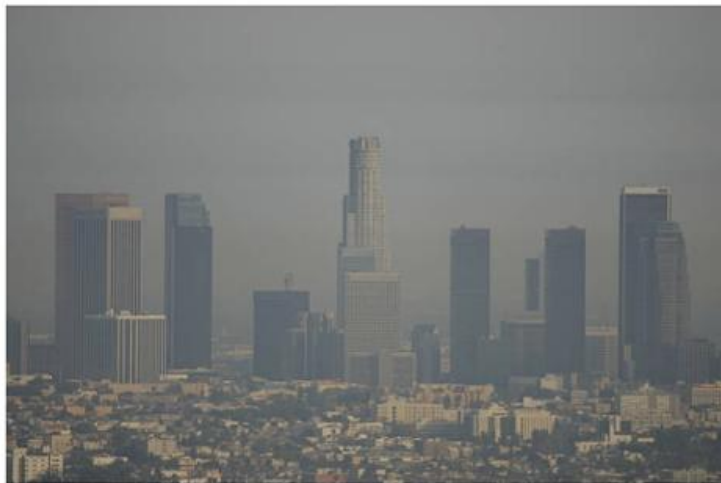
NASA

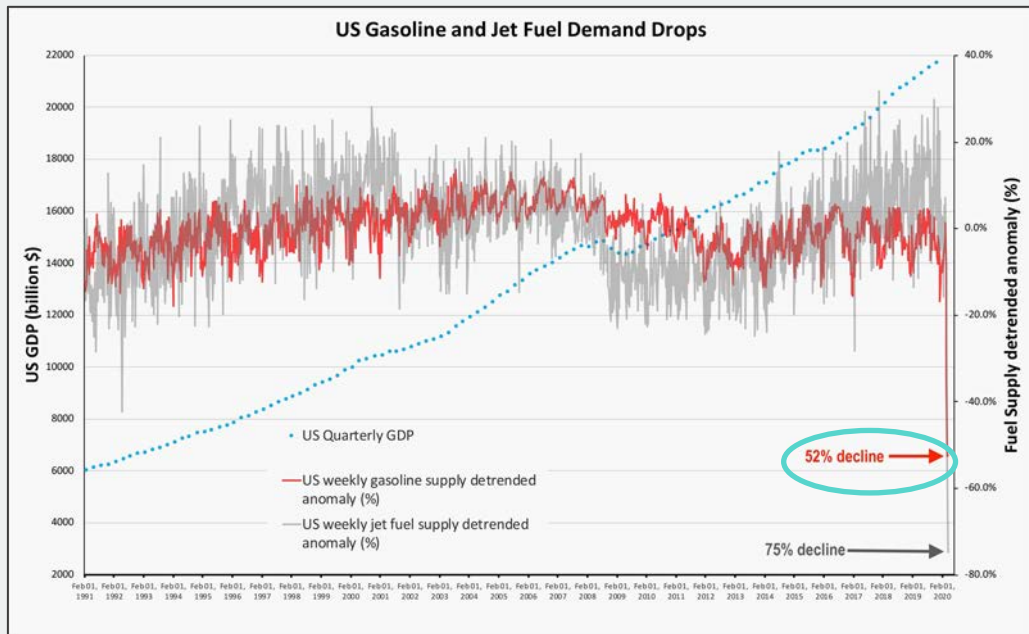




**New  
Delhi**

**Los  
Angeles**





Kevin Gurney/WIRED



Getty Images

### After the 2008 Financial Crisis:

2009 – 1.4% decrease in CO<sub>2</sub> emissions

2010 – 5.9% increase in CO<sub>2</sub> emissions

2011 – 3% increase in CO<sub>2</sub> emissions

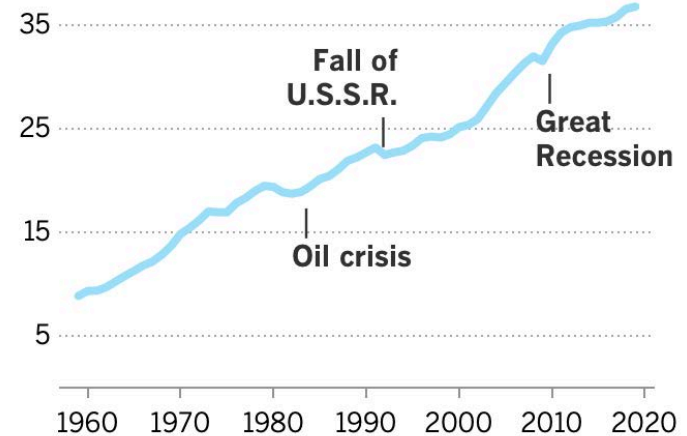
2012 – 1.4% increase in CO<sub>2</sub> emissions

2013 – 2.3% increase in CO<sub>2</sub> emissions

## Carbon pollution in times of crisis

Emissions briefly drop during economic downturns, only to climb again

Billions of metric tons of CO<sub>2</sub>



Global Carbon Project

Tony Barboza

# Pandemic Impact on Climate Action

- Key climate meetings postponed:
  - UN annual climate summit– from Nov. 2020 → 2021
  - UN biodiversity summit (COP15) – from Oct. 2020 → 2021
  - The second UN Ocean Conference – from Jun. 2020 → future date TBD
- Climate research and fieldworks slowed or halted:
  - NASA observing teleworking mandates and fieldwork cancelled
  - Arctic research paused due to travel restrictions



# Pandemic Impact on Climate Action

- Climate activism less visible due to social distancing requirements
  - 50<sup>th</sup> Earth Day anniversary celebrated virtually, and climate protests pushed online
- Political will for climate action weakened – pandemic dominating attention and resources
  - Renewables excluded from US stimulus spending
  - Calls to postpone European Green Deal

# Pandemic Impact on Climate Action

- Environmental standards and enforcement relaxed to ease pressure on industries
  - US rolling back fuel economy standards; EPA not penalizing companies that fail to comply with federal monitoring requirements
  - Poland called for carbon trading program to be put on hold
  - China delaying emissions-cutting policies

# Pandemic Lessons for Climate Response

- Planetary health and human wellbeing are inextricably linked:
  - Human survival and flourishing dependent on a healthy planet
  - Teach us a sense of humility that nature isn't for us to use as we wish



- Both people and governments can mobilize quickly
- Radical shifts in behavior possible
  - Changes in handwashing practices
  - Implementing radical social distancing policies
  - Wearing masks

# Pandemic Lessons for Climate Response



- Robust government response is key, including international collaboration.
- Investments in prevention are less economically disruptive than reacting to a crisis.
- Crises are opportunities to fundamentally change how we live and work to create a more equitable and sustainable planet.

# Where do we go from here?

- ✓ Capitalize on the moment
  - Reinforce importance of preventative measures
  - Remind people big change and action possible
  - Green energy paradigm shift
- ✓ Continue workplace and behavior changes
- ✓ Direct stimulus funding towards renewable energy
- ✓ Address risk factors for vulnerable populations
- ✓ Regain a sense of shared humanity

# Time for a “Climate Reset”



# Take Away Points

- Planetary health and human wellbeing are inextricably linked.
- Climate change can act as a threat amplifier for the COVID-19 pandemic.
- Environmental conditions are responsive to changes in human behavior.
- The pandemic presents a unique opportunity for **regenerative recovery**.

*Thank you*

*Acknowledgements: Adrienne  
Epstein &  
Jennifer Zakaras*

The UCSF logo is displayed in a white square. It consists of the letters 'UCSF' in a bold, black, sans-serif font. The 'U' and 'C' are connected, and the 'S' and 'F' are also connected. The background of the slide is an aerial view of San Francisco, showing the city's dense urban landscape, green hills, and the Transamerica Pyramid tower in the distance.

UCSF

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