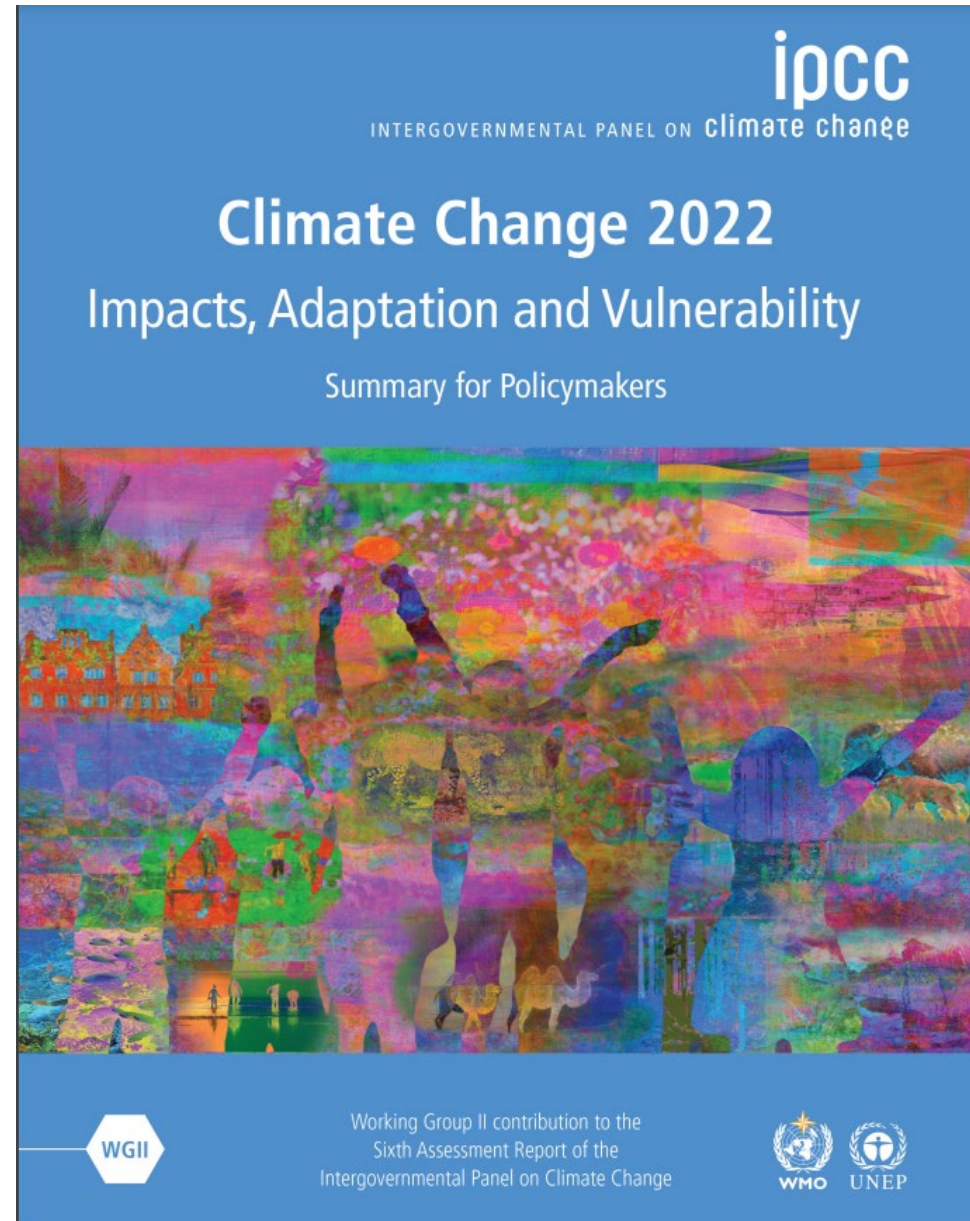


# Climate Change and Cancer

Leticia M. Nogueira, PhD MPH  
American Cancer Society

**Climate change is the  
greatest threat to human  
health of our time.**



**Climate Change is already  
impacting the health of  
individuals across the US**

# Climate Change

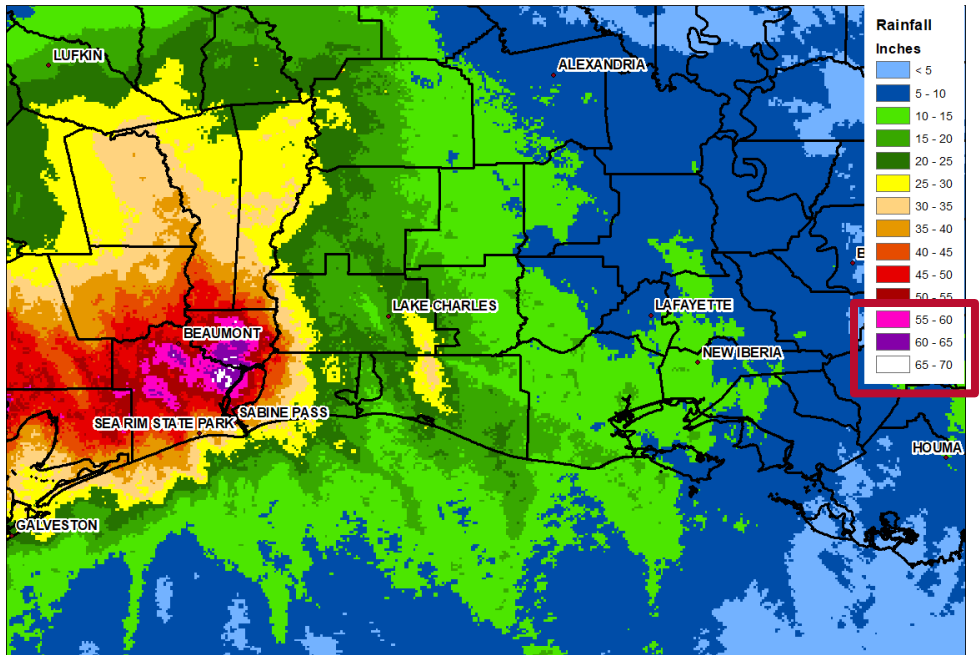
Alters the behavior of extreme weather events



Extreme Weather Events

Warmer air holds more water vapor, which increases the water capacity of hurricanes

Harvey Radar Derived Storm Total Rainfall



Rainfall over Houston during Hurricane Harvey  
National Oceanic and Atmospheric Administration (NOAA)

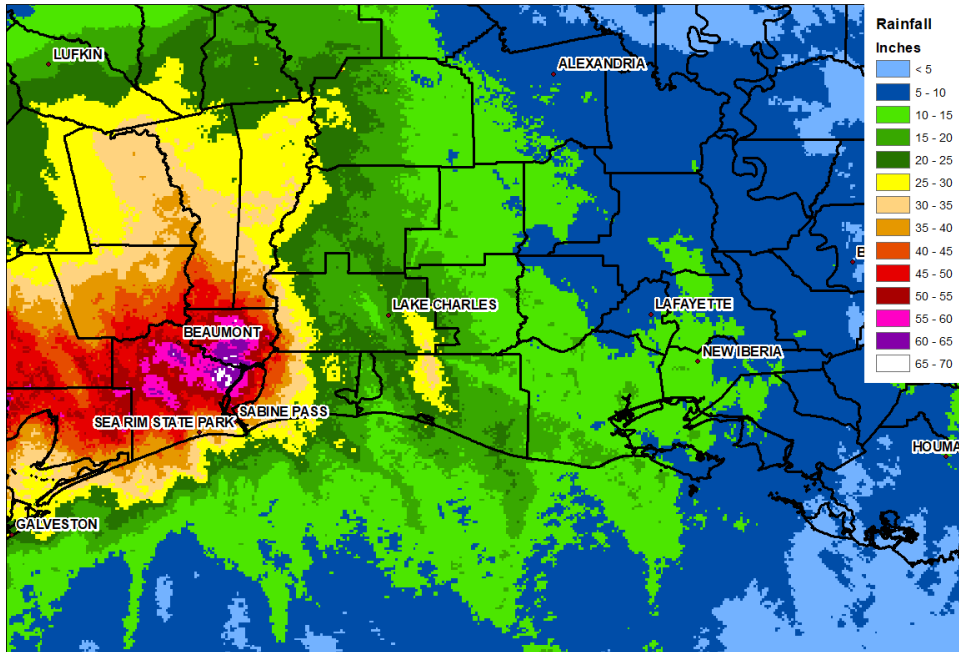


Kossin JP. Aglobal slowdown of tropical-cyclone translation speed. Nature. 2018;558:104-107 | Emanuel K. Assessing the present and future probability of Hurricane Harvey's rainfall. Proc Natl Acad Sci U S A. 2017;114:12681-12684

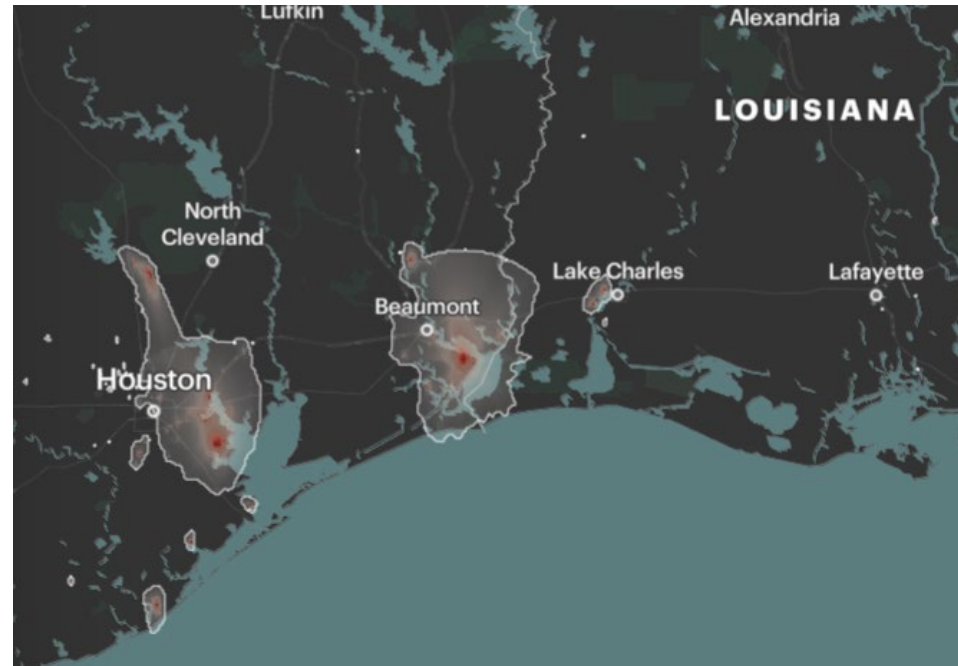
# Climate Change Alters the Behavior of Storms

Hurricane Harvey flooded chemical plants, oil refineries, and Superfund sites

Harvey Radar Derived Storm Total Rainfall



Rainfall over Houston during Hurricane Harvey  
National Oceanic and Atmospheric Administration (NOAA)



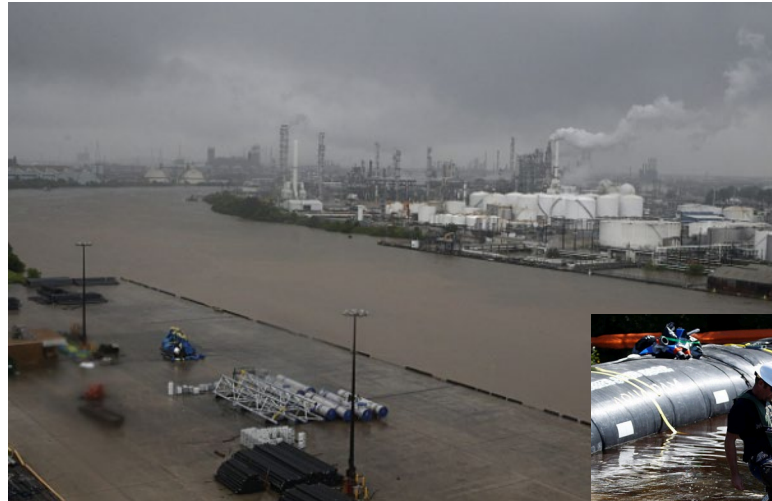
Cancer-causing industrial pollution  
<https://projects.propublica.org/toxmap/>



Kossin JP. Aglobal slowdown of tropical-cyclone translation speed. Nature. 2018;558:104-107 | Emanuel K. Assessing the present and future probability of Hurricane Harvey's rainfall. Proc Natl Acad Sci U S A. 2017;114:12681-12684

# Climate Change – Storm Behavior

Increase community exposure to carcinogens



Houston Ship Chanel



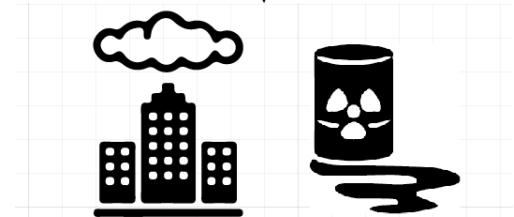
Arkema Chemical Plant



Climate Change



Extreme Weather Events



Exposure to Carcinogens

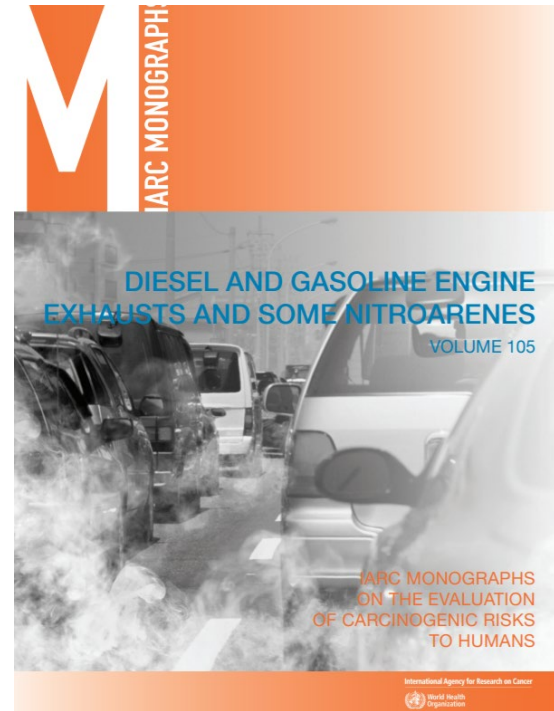


Risser MD, Wehner MF. Attributable human-induced changes in the likelihood and magnitude of the observed extreme precipitation during hurricane Harvey. *Geophys Res Lett.* 2017;44:12-457

# Where are these carcinogens coming from?

# Reliance on Fossil Fuels

Shared cause of climate change and rise in exposure to carcinogens



Extraction  
Processing  
Transportation  
Waste Management



Fossil Fuels



Exposure to Carcinogens



Silverman DT. Diesel Exhaust and Lung Cancer-Aftermath of Becoming an IARC Group 1 Carcinogen. *Am J Epidemiol.* 2018 Jun 1;187(6):1149-1152. doi: 10.1093/aje/kwy036.



# Natural Gas Extraction - Fracking

Carcinogens released during fossil fuel extraction

Methane can leak accidentally, or it may be vented intentionally. Methane can also be flared (shown), which is a controlled burn used for testing, safety, and waste management.

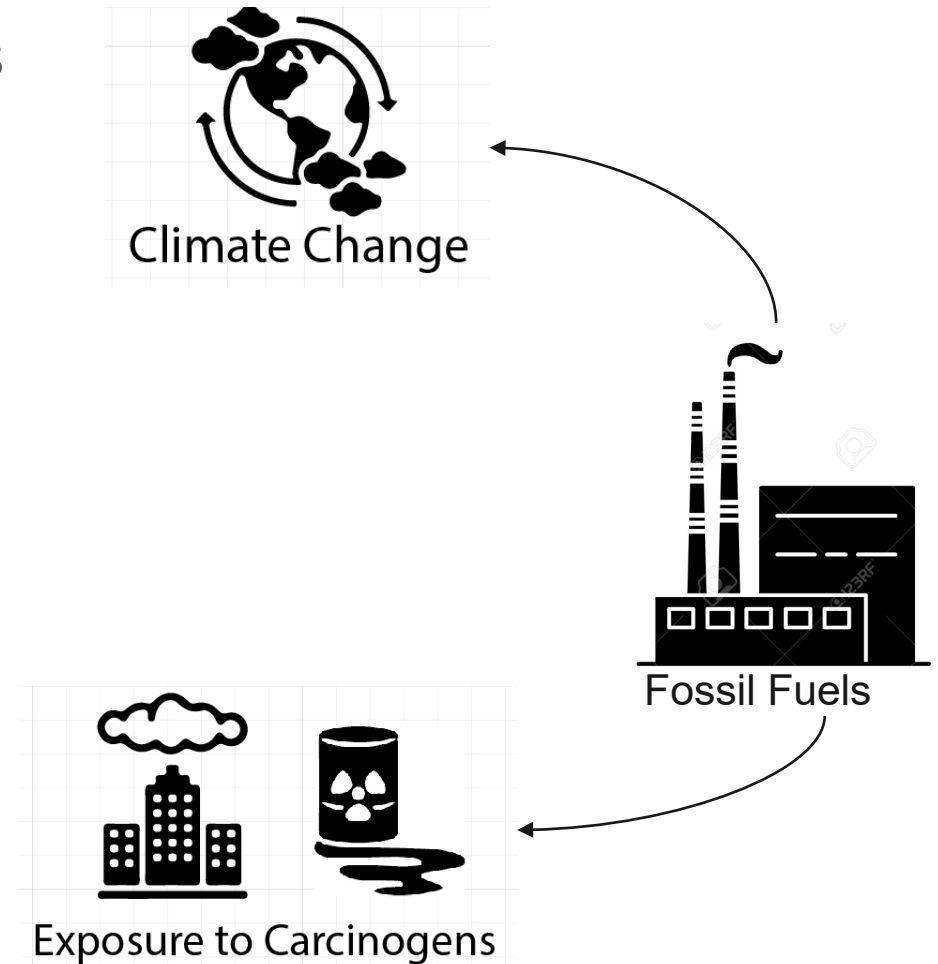


# Reliance on Fossil Fuels

Shared cause of climate change and rise in carcinogens

**1** | Extraction

**2** | Processing



# Oil Refineries - Superfund Sites

Carcinogens released during fossil fuel processing

## **Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)**

Administered by the Environmental Protection Agency  
(EPA)

Investigate and cleanup sites contaminated with  
hazardous substances



<https://www.epa.gov/superfund/superfund-site-assessment-process#:~:text=The%20Superfund%20site%20assessment%20process,tribes%20or%20other%20environmental%20programs>

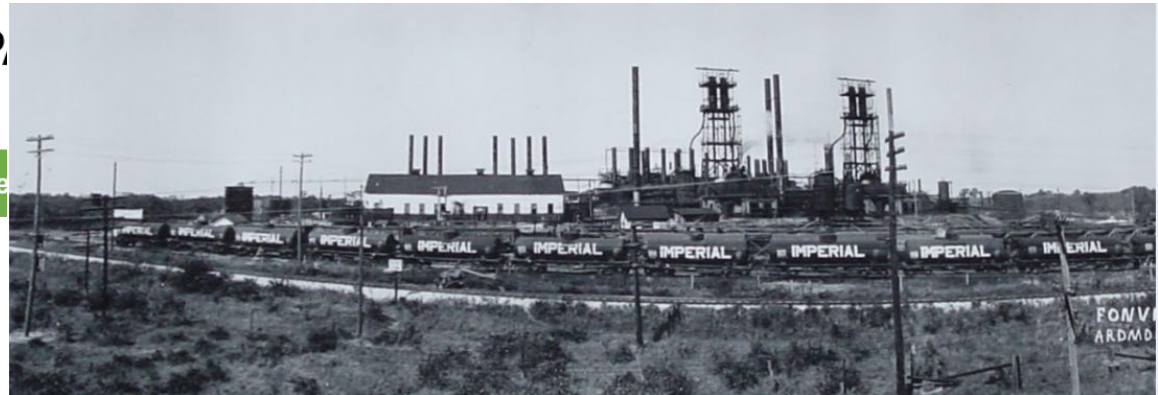
# Superfund Sites

Carcinogens Released During Fossil Fuel Processing

Major Components of EPA



Wilcox Oil Company Superfund Site, OK



Imperial Refining Co. Superfund Site, OK (SI)

System Package (USP)

(as necessary)

Priorities List (NPL)



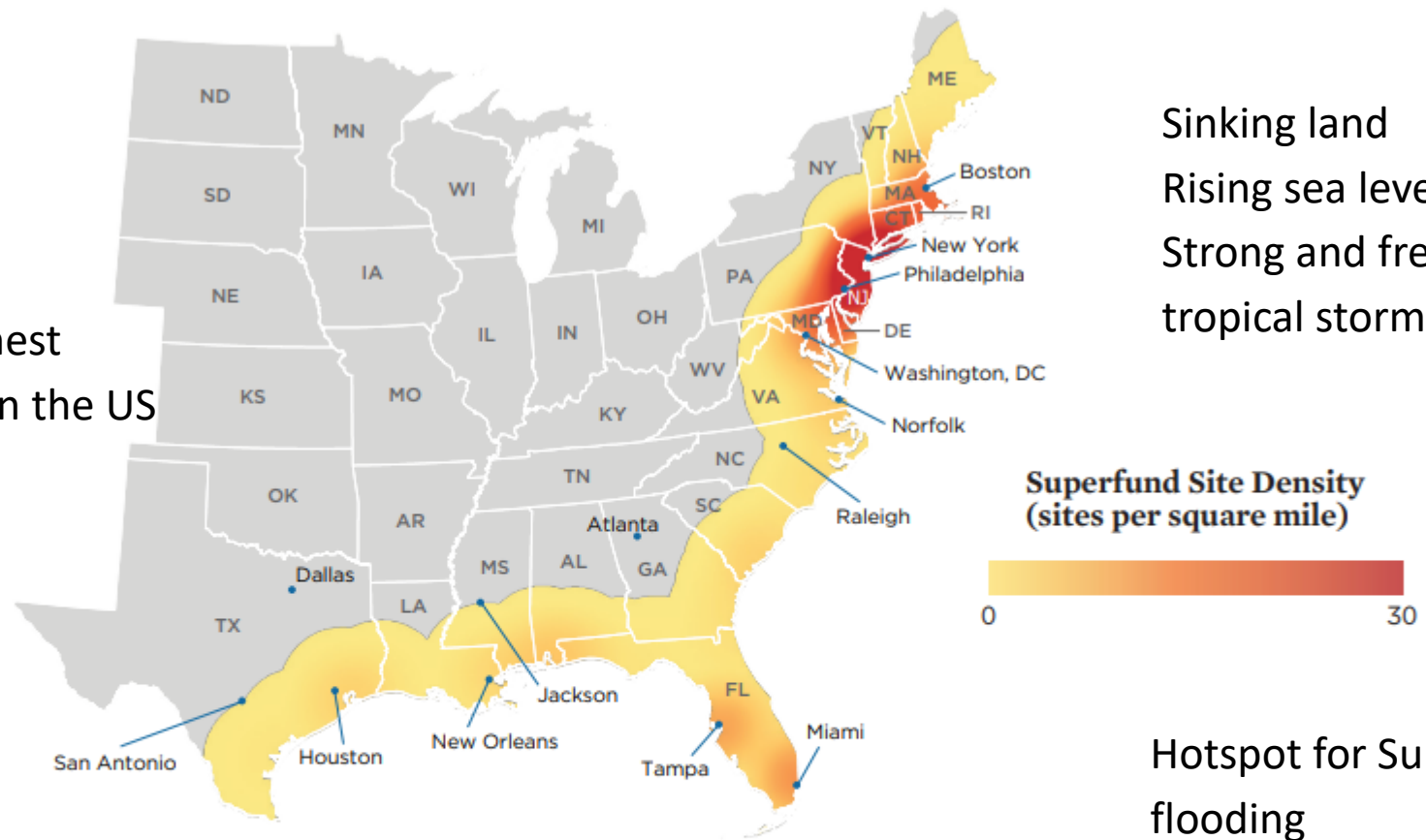
Sinclair Refinery Superfund Site, NY



Texaco Refinery Superfund Site, IL

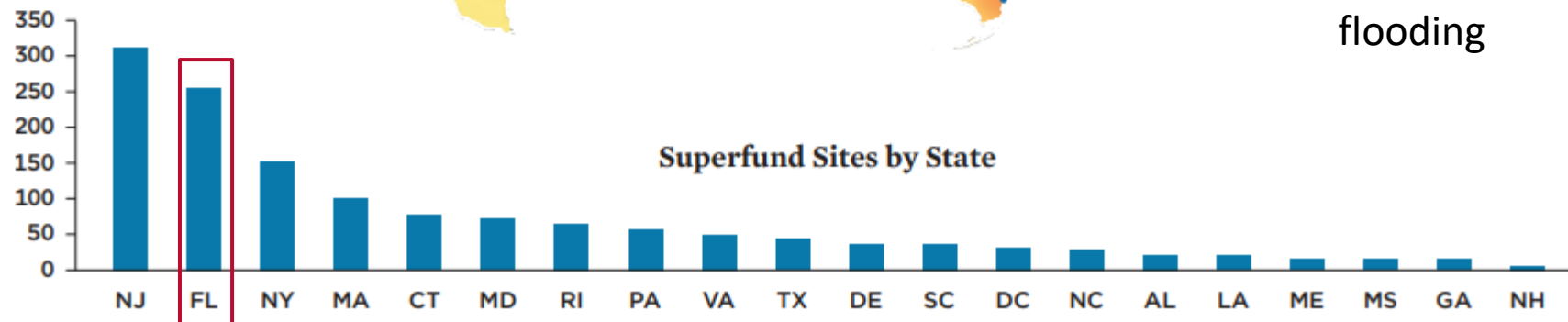


Florida has one of the highest density of superfund sites in the US



Sinking land  
Rising sea levels  
Strong and frequent extreme tropical storms

Hotspot for Superfund site flooding



*All states along the East and Gulf Coasts have Superfund sites close to the coastline. Florida, New Jersey, and New York are particular hotspots. Flooding of any of these sites could cause extensive health damage to surrounding communities.*

# Reliance on Fossil Fuel

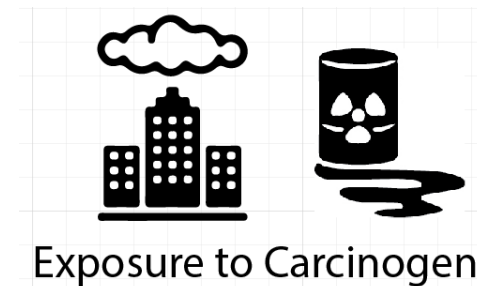
Shared cause of climate change and rise in carcinogens

1 Extraction

2 Processing



Refineries in operation today release carcinogens in the air, water, and soil during processing of fossil fuels



# Rise in Carcinogens During Fossil Fuel Processing

## Oil Refineries

### Petroleum products

- Fuel
- Chemicals
- Plastic

**COMMON PRODUCTS MADE FROM NATURAL GAS & OIL**

Did you know that American natural gas and oil does more than generate clean, reliable electricity? Everything from cell phones to life-saving medications are made possible by our abundant domestic resources.

MARCELLUS SHALE COALITION

MEDICAL

MarcellusCoalition.org

**PETROLEUM PRODUCTS**

From Crude Oil to Useful Products: the Petroleum Value Chain

Gasoline	4.0
Diesel fuel	25.9
All other products (including petrochemical feedstocks)	14.0
Light fuel oil	7.2
Heavy fuel oil	6.8
Aviation fuel	3.9
Asphalt	3.9
Propane/butane	2.6

**1 CRUDE OIL PRODUCTION AND TRANSPORT**  
Canada produces 4.6 million barrels per day of crude oil from conventional, unconventional (e.g. tight and shale oil), oil sands and offshore sources. These are moved via pipeline, tanker and rail to upgraders and refineries here in Canada, and to markets in the United States and overseas.

CONVENTIONAL UNCONVENTIONAL AND OIL SANDS IN SITU | OIL SANDS MINING | OFFSHORE

**2 REFINING AND UPGRADING**  
Refineries turn crude oil into usable products like transportation fuels and feedstock for petrochemical plants. Upgraders turn bitumen into synthetic crude oil that can then be processed at a refinery.

**DID YOU KNOW?** Canada's 16 refineries produce nearly **25.8 billion litres** of refined petroleum products per day.

PIPELINE | MARINE | RAIL

BITUMEN | OTHER CRUDE OILS

UPGRADER | REFINERY

**3 FUELS AND PETROCHEMICALS**  
Transportation fuels are essential to the mobility of people, goods and services; and our quality of life. Some refined products are used directly as transportation fuels, while others are sent to petrochemical plants where they are turned into thousands of essential products we use in our everyday lives.

PETROCHEMICAL PLANT | FUEL DISTRIBUTION

COSMETICS | TEXTILES | PLASTICS | GASOLINE | DIESEL | JET FUEL

Learn more about the petroleum value chain with the Canadian Fuels Association at [canadianfuels.ca](http://canadianfuels.ca).



# Petroleum Products – Plastic

Only 9% of plastic is recycled

Management Pathway	1960	1970	1980	1990	2000	2005	2010	2015	2017	2018
<b>Generation</b>	390	2,900	6,830	17,130	25,550	29,380	31,400	34,480	35,410	35,680
<b>Recycled</b>	-	-	20	370	1,480	1,780	2,500	3,120	3,000	3,090
<b>Composted</b>	-	-	-	-	-	-	-	-	-	-
<b>Combustion with Energy Recovery</b>	-	-	140	2,980	4,120	4,330	4,530	5,330	5,590	5,620
<b>Landfilled</b>	390	2,900	6,670	13,780	19,950	23,270	24,370	26,030	26,820	26,970

Sources: Plastics information is from the American Chemistry Council, the National Association for PET Container Resources and The Association of Plastic Recyclers.



<https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data>



# Reliance on Fossil Fuel

Shared cause of climate change and rise in carcinogens

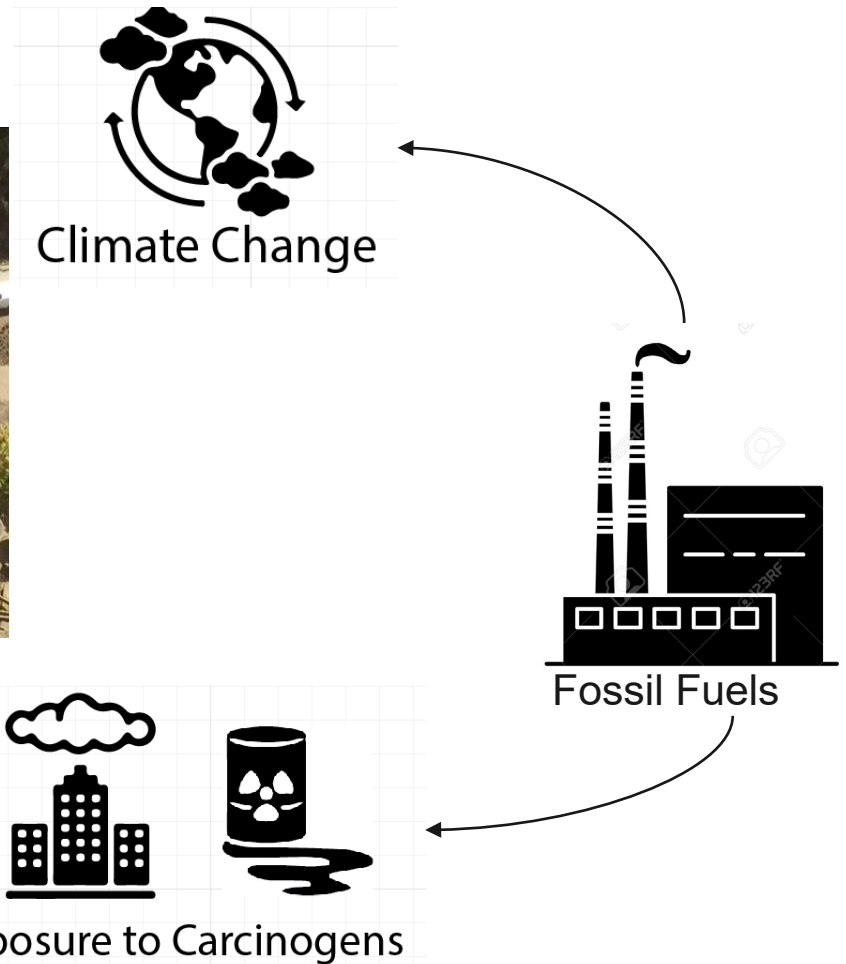
- 1 Extraction
- 2 Processing
- 3 Transportation



<https://www.nrdc.org/stories/natural-gas-101>



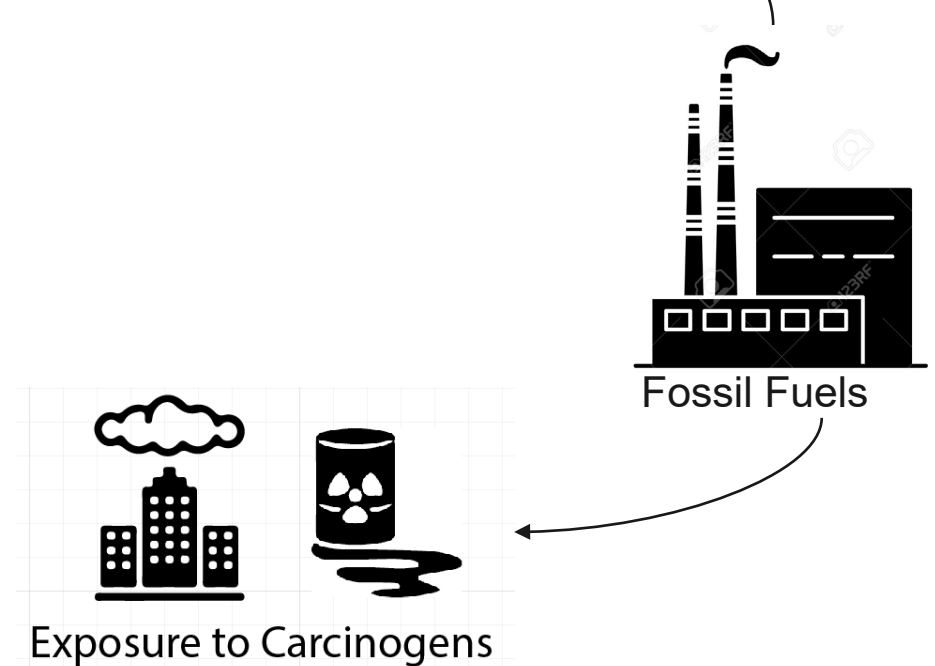
<https://www.nrdc.org/sites/default/files/tarsandssafetyrisks.pdf>



# Reliance on Fossil Fuel

Shared cause of climate change and rise in carcinogens

- 1 Extraction
- 2 Processing
- 3 Transportation
- 4 Consumption



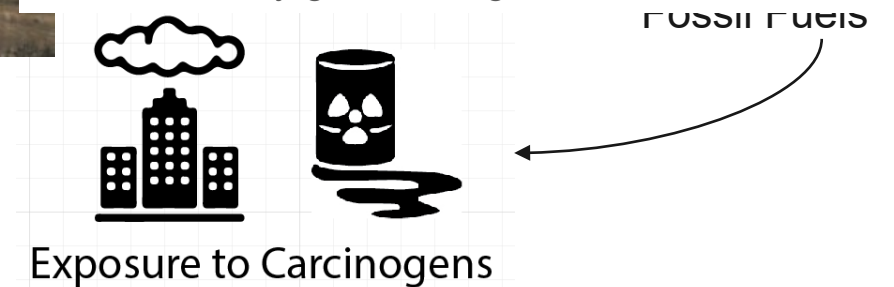
# Reliance on Fossil Fuel

Shared cause of climate change and rise in carcinogens

- 1 Extraction
- 2 Processing
- 3 Transportation
- 4 Consumption
- 5 Waste



Coal Ash Ponds  
<https://grist.org/article/why-obamas-plans-to-clean-up-coal-ash-barely-got-off-the-ground/>

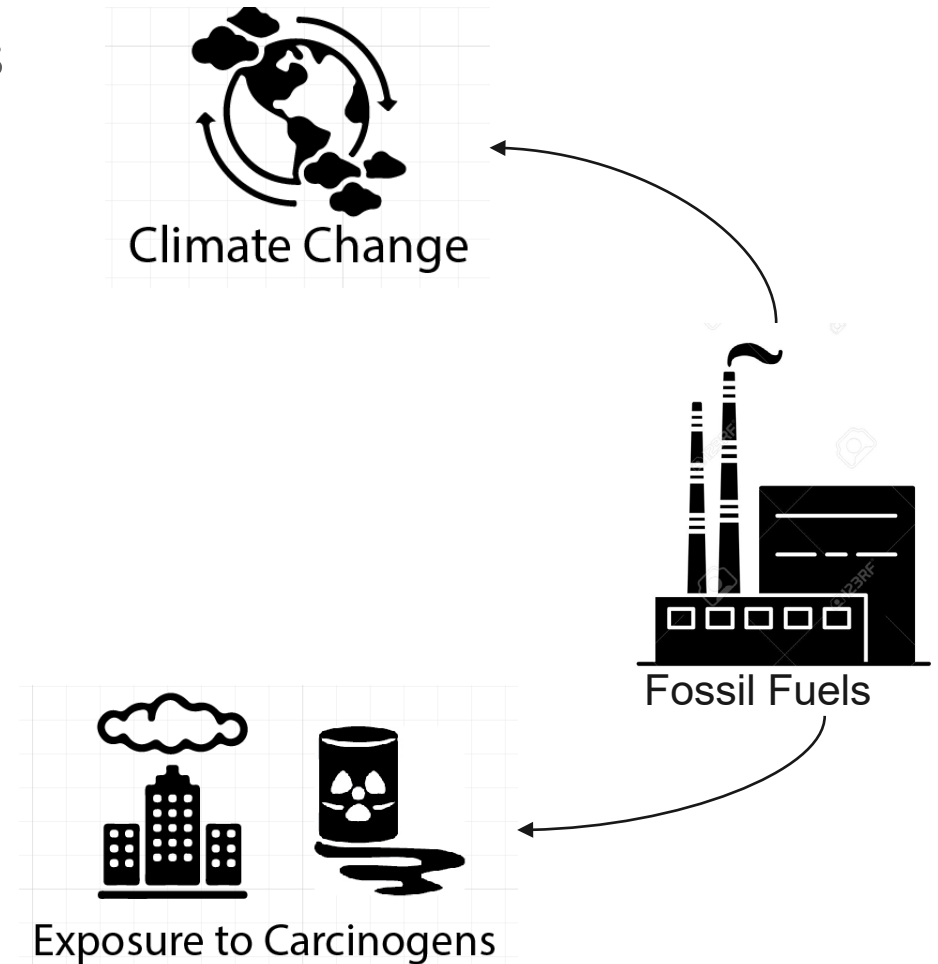


# Reliance on Fossil Fuel

Shared cause of climate change and rise in carcinogens

- 1 Extraction
- 2 Processing
- 3 Transportation
- 4 Consumption
- 5 Waste

Each step contributes to both climate change and increased exposure to carcinogens



# Disruptions in Access to Care

Changing frequency and behavior of extreme weather events



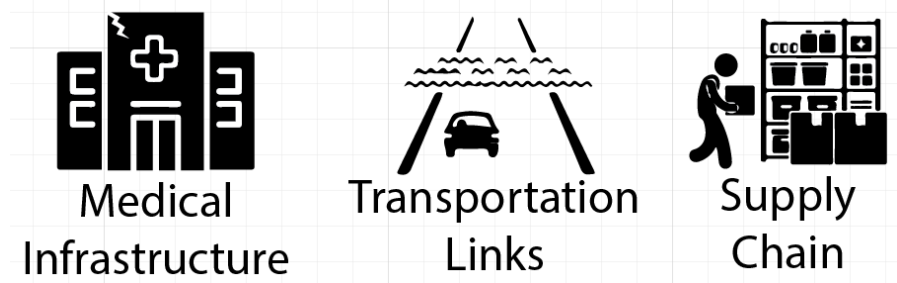
Hurricane Maria's devastation includes national shortage of a critical medical supply

*The hurricane brought down power in Puerto Rico where many IV bags are made.*

<https://abcnews.go.com/US/hurricane-marias-devastation-includes-national-shortage-critical-medical/story?id=52338843>



Extreme Weather Events



Hurricane Harvey

# Impact of Hurricanes on Access to Care

Among individuals who have been diagnosed with cancer

## National Cancer Database

American Cancer Society

American College of Surgeons

- Hospital-based
- ~70% of cancer cases in the US



## Federal Emergency Management Agency (FEMA)

Presidential Disaster Declarations

Facilities Impacted by a Hurricane

# Impact of Hurricanes on Access to Care

Among cancer patients undergoing radiation therapy

## Receipt of Radiation Therapy

- Electricity
- Specialized Teams
- Daily Schedule

## Non-Small Cell Lung Cancer (NSCLC)

- Non-operable
- Locally advanced

## Patients whose facility was impacted by a hurricane during radiation treatment

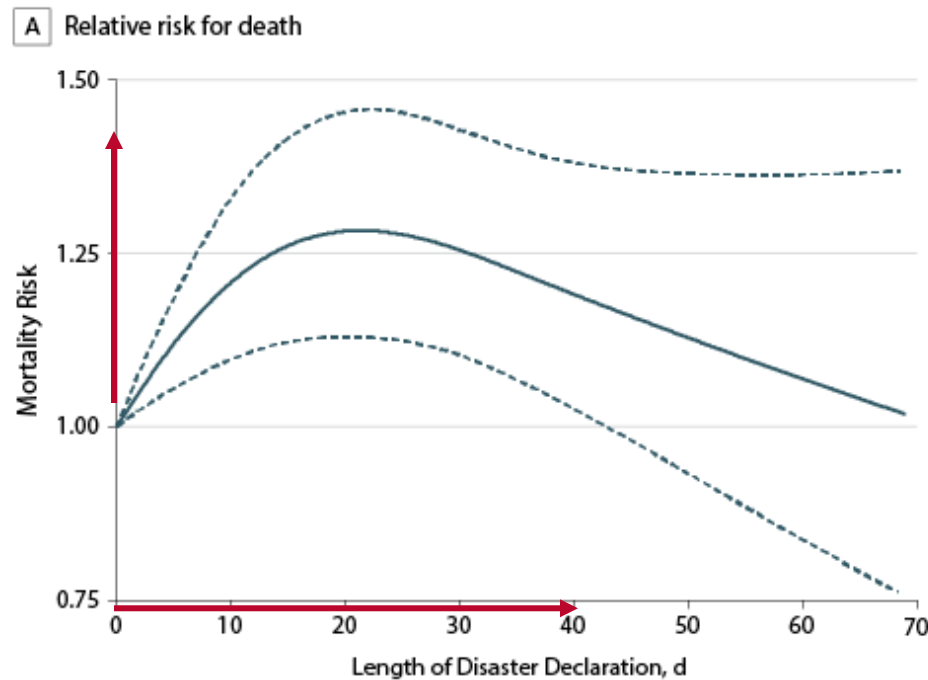
## Propensity Score Matched

- Relevant clinical characteristics
- Same facility
- No disaster declarations

# Impact of Hurricanes on Cancer Patients

Disruptions in access to care and worse survival

Figure. Association Between Length of Hurricane Disaster Declaration and Risk of Death in Patients With Lung Cancer Undergoing Radiation



**Worse overall survival**

HR (95% CI)  
1.19 (1.07, 1.32)



# Facilities Impacted by Hurricanes

American Hospital Association (AHA) + FEMA (2016-2020)



# Facilities Impacted by Extreme Weather Events

American Hospital Association (AHA) + FEMA (2016-2020)

Severe Storm (37%)



Flood (28%)



Severe Ice Storm (17%)



# Facilities Impacted by Extreme Weather Events

American Hospital Association (AHA) + FEMA (2016-2020)

All types of disasters (99%)



# Emergency Preparedness Plans

For individuals diagnosed with cancer



Centers for Disease Control and Prevention  
CDC 24/7: Saving Lives, Protecting People™

Many cancer centers do not provide a survivorship care plan

🏠 Cancer Survivors

Cancer Patients: Diagnosis and Treatment

## Be Prepared for an Emergency

[Español \(Spanish\)](#)

### Get a Kit

Pack an emergency supply kit that includes—

- Enough bottled water and food to last at least three days.
- Enough medicine and medical supplies to last at least seven days.
- A copy of your [cancer survivorship care plan](#), if you have one, or your doctor's name and phone number and a list of medicines you take.
- A list of phone numbers and e-mail addresses for people who are important to stay in touch with.

Some medications are not eligible for extra supplies (e.g. pain medication)

See a [detailed list of personal needs](#) to pack in your kit, and more information about packing [an emergency supply of medicine](#).

# Emergency Preparedness Plans

Burden on the individual



<https://www.washingtonpost.com/weather/2021/05/02/california-wildfire-season-growing/>



<https://psmag.com/environment/fixing-americas-disability-disaster-response>

# Emergency Preparedness Plans

Required for all Medicare and Medicaid participating providers by CMS



## Emergency Preparedness Rule

Does not require Emergency Preparedness Plans to be shared

How many institutions are compliant with this requirement?

**Emergency Preparedness Rule**

**Quality, Safety & Oversight Group- Emergency Preparedness Regulation Guidance**

**Guidance for Surveyors, Providers and Suppliers Regarding the New Emergency Preparedness (EP) Rule**

Are these plans tailored to the population served and the common disasters in the area?

On September 8, 2016 CMS published in the Federal Register the *Emergency Preparedness Requirements for Medicare and Medicaid Participating Providers and Suppliers Final Rule*. The regulation became effective November 16, 2016. Health care providers and suppliers affected by this rule were to be compliant and implement all regulations one year after the effective date, on November 15, 2017.

No lessons learned



# Disruptions in Access to Care

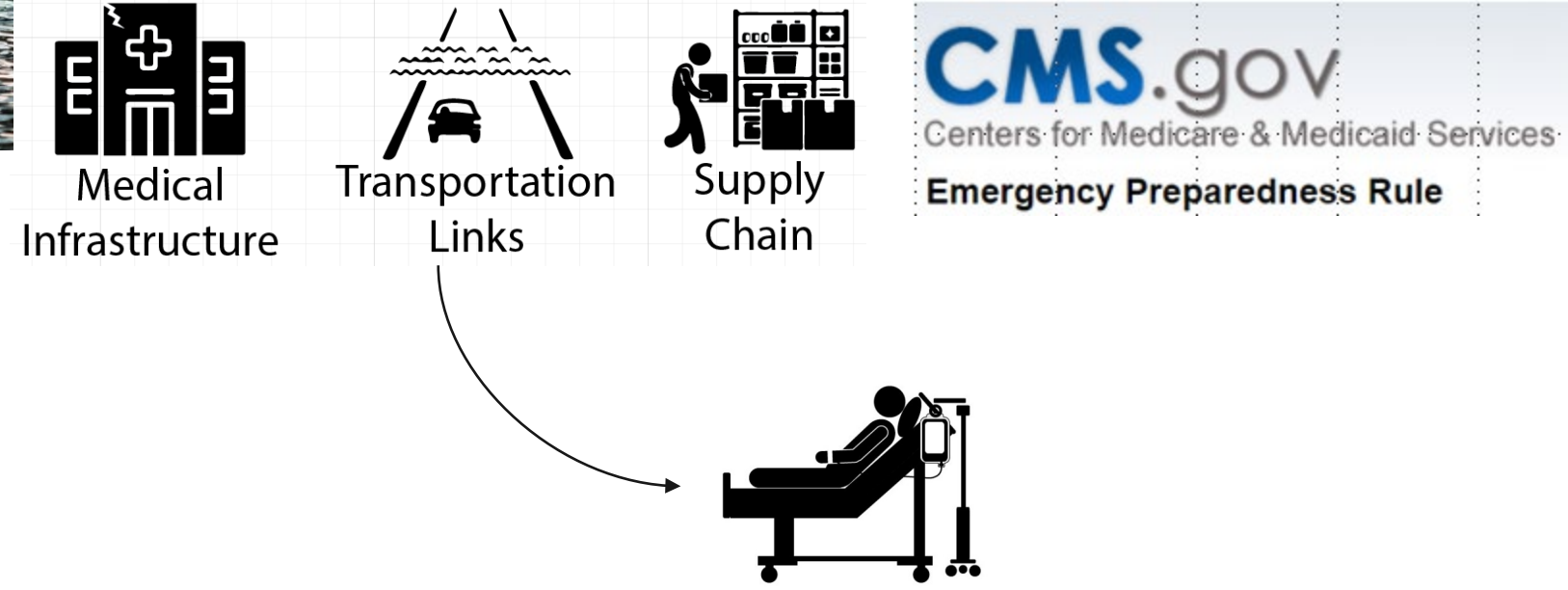
Changing frequency and behavior of extreme weather events



Burden on the individuals  
<https://aging.com/disaster-preparedness-for-seniors/>



Extreme Weather Events



# Beyond disruptions in access to care

## Consequences of cancer diagnosis and treatment

- Physical
- Psychological
- Socioeconomic

**Individuals diagnosed with cancer are a vulnerable population to the health hazards of climate change**



# Individuals diagnosed with cancer

Vulnerable population to the health hazards of climate change

## Physical consequences

- Organ Damage
- Weakened Immune System
- Anemia
- Fatigue
- Dehydration

## Psychological consequences

- Depression
- Cognitive impairment

## Increased sensitivity to climate change health hazards

- Heat waves
- Infections during floods
- Respiratory issues during wildfires



# Individuals diagnosed with cancer

Vulnerable population to the health hazards of climate change

## Socioeconomic consequences

Financial Hardship

- Out-of-pocket expenses
- Ability to remain employed

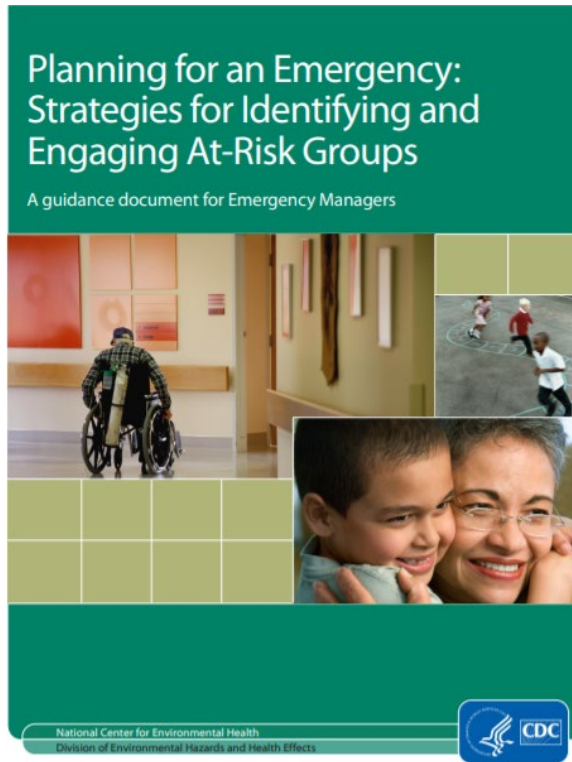
## Harder to prepare and respond to disasters

- Ability to evacuate
- Stockpile food
- Housing infrastructure
  - Insulation
  - Air conditioning
  - Air filters

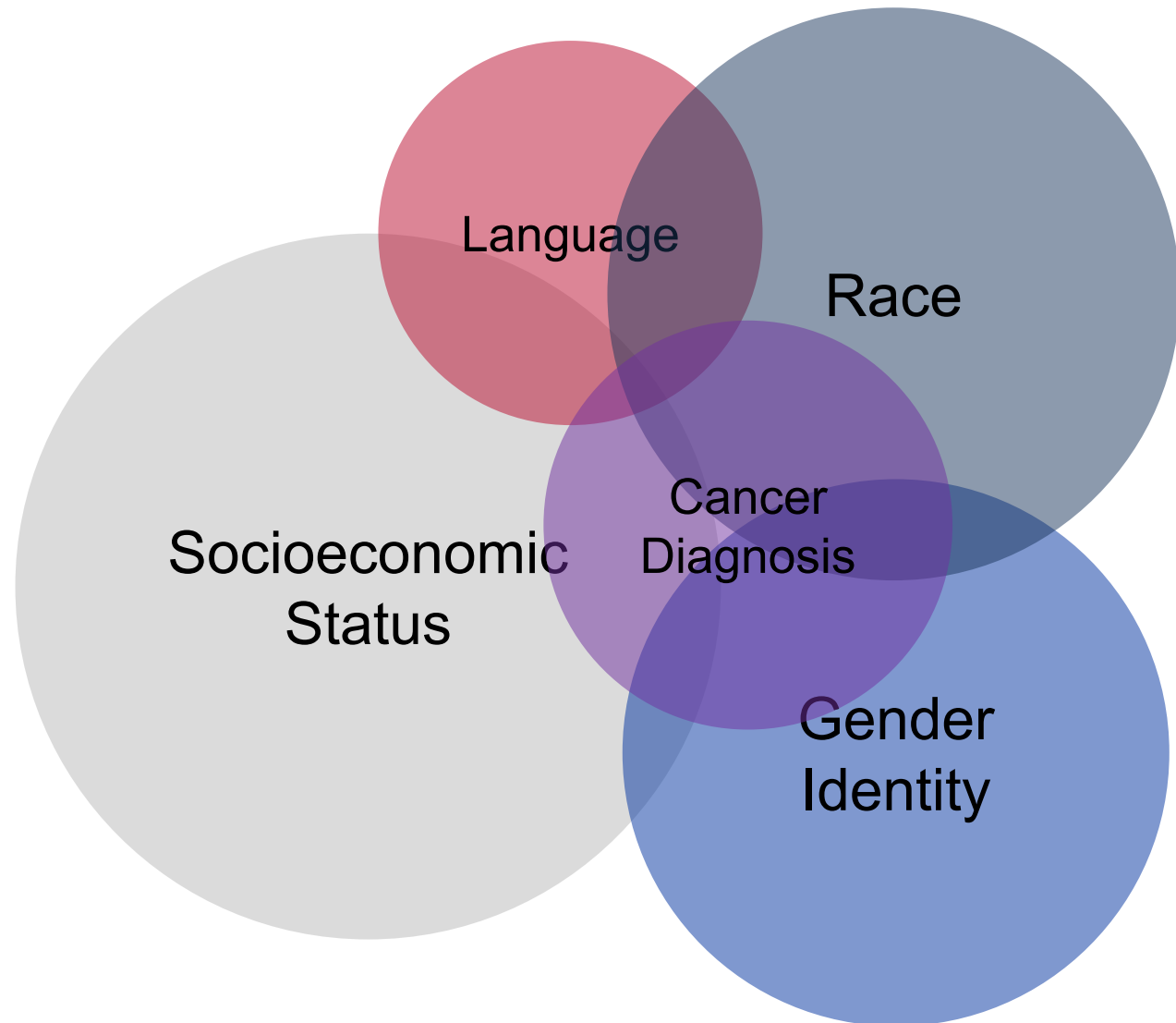


# Climate Change

## Vulnerable Populations



<https://www.cdc.gov/nceh/hsb/disaster/atriskguidance.pdf>

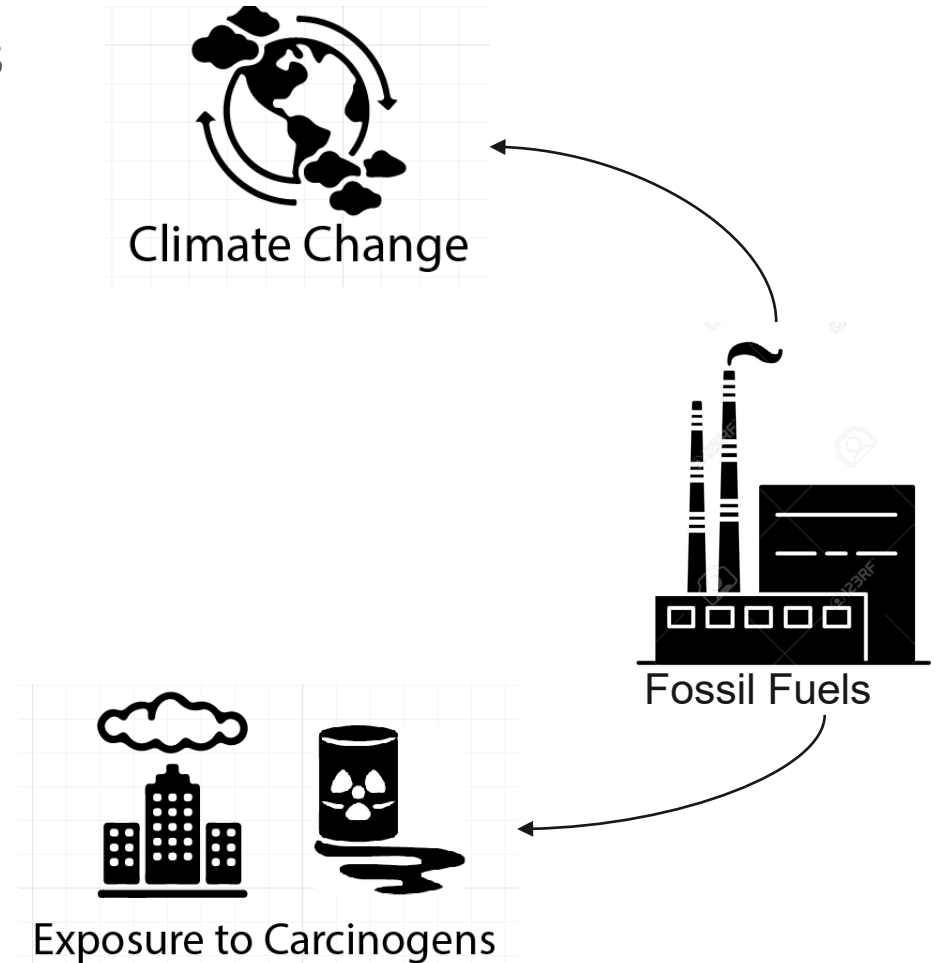


# Conclusion

# Reliance on Fossil Fuel

Shared cause of climate change and rise in carcinogens

- 1 Extraction
- 2 Processing
- 3 Transportation
- 4 Consumption
- 5 Waste



# Climate Change

Alters the frequency and behavior of extreme weather events

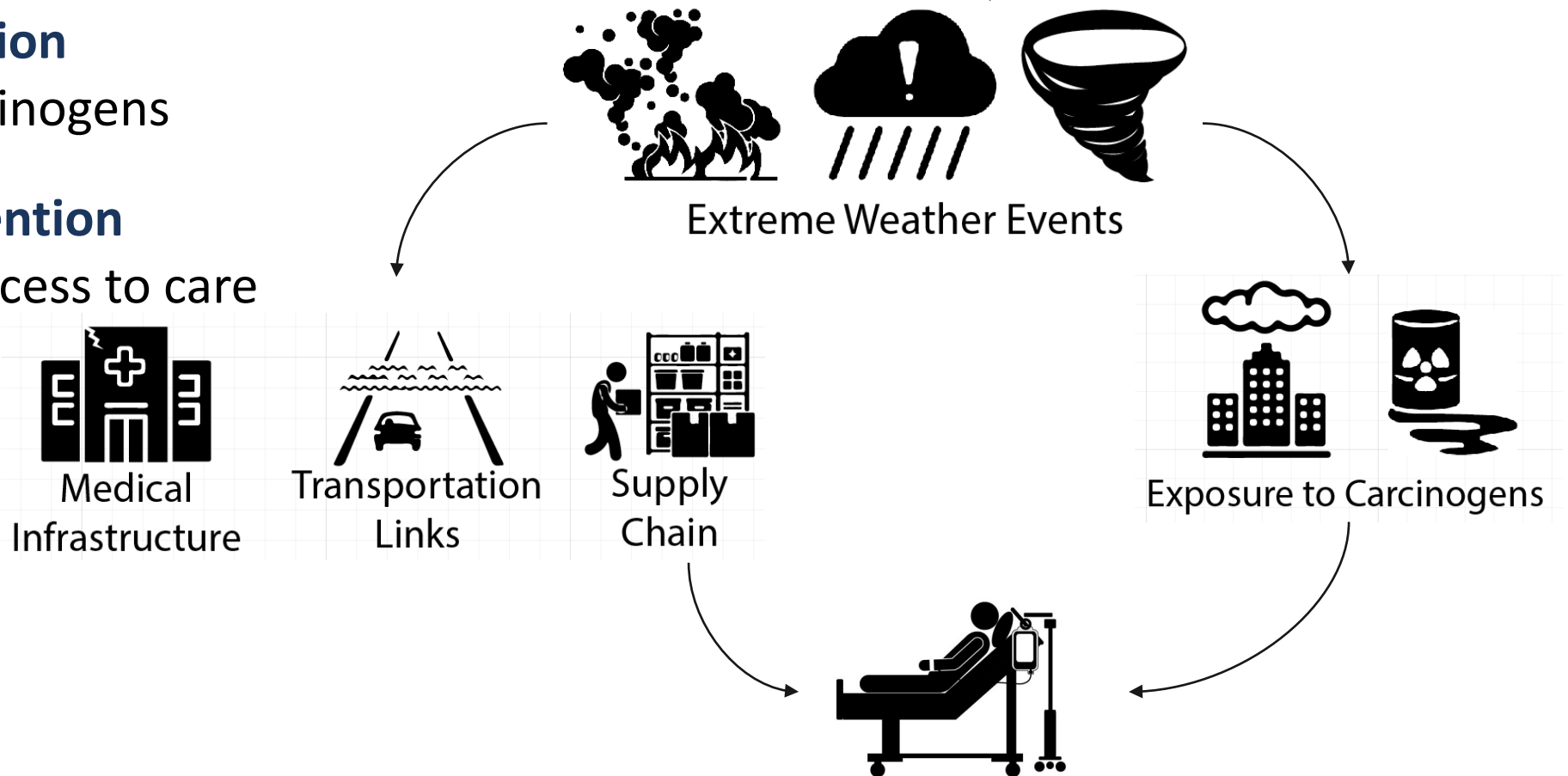


## Primary Prevention

Exposure to carcinogens

## Secondary Prevention

Disruptions in access to care



# Intersectionality

Vulnerability to the health threats of climate change

## Sensitivity

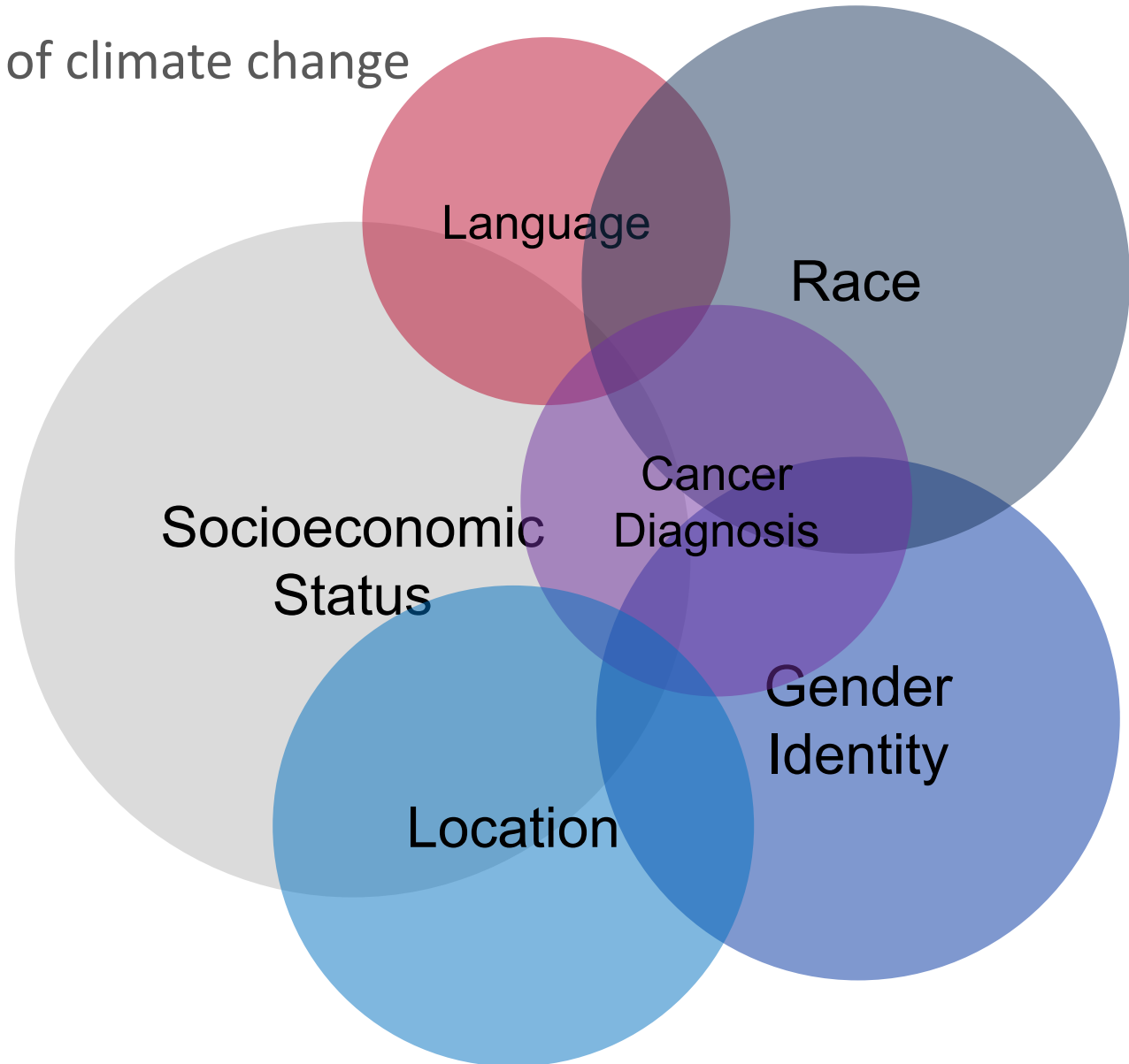
The degree to which climate hazards impact humans

## Exposure

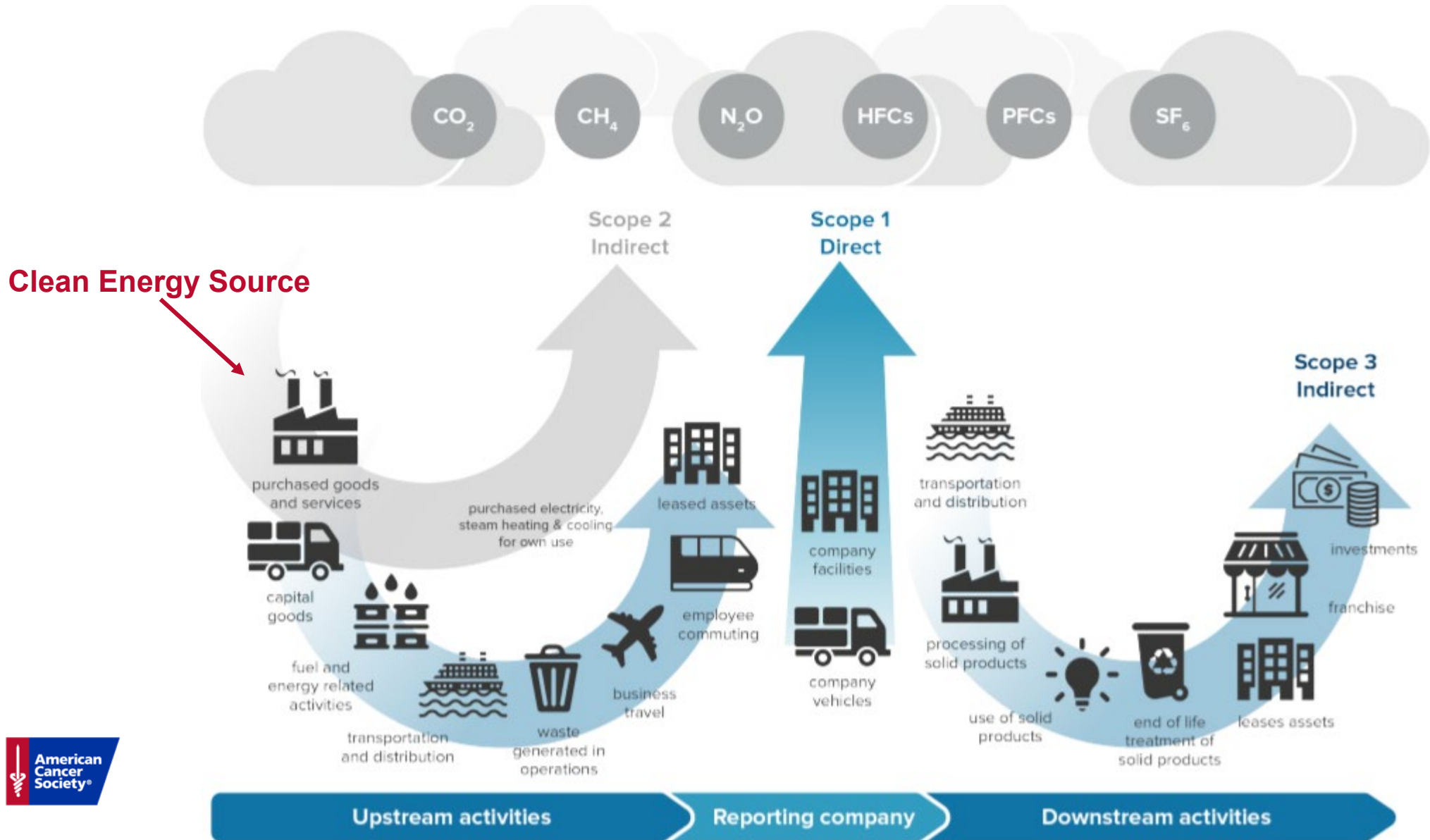
Human contact with environmental hazards

## Adaptative Capacity

Ability to cope with climate hazards



# Healthcare System Emissions





# Reduce Healthcare System Emissions

Promote better health outcomes due to health co-benefits of climate mitigation strategies

**TABLE 1. Sources of Greenhouse Gas Emissions from Cancer Care and Proposed Interventions**

	SOURCES OF GREENHOUSE GAS EMISSIONS	PROPOSED INTERVENTIONS
Energy	On-site energy expenditure and environmental impact of power sources	Increase use of renewable energy that is generated on-site; energy-efficient, occupation-based strategies for heating, ventilation, and air conditioning
Pharmaceuticals	Chemotherapy, immunotherapy, surgery anesthetics	Encourage pharmaceutical companies to measure and report their carbon footprint and prioritize low emission pharmaceuticals
Medical devices	Imaging, surgery, radiation therapy, systemic therapy, palliative care	Prioritize the use of energy-efficient medical devices and promote sustainable manufacturing
Food	Food manufacture, delivery, and waste	Reduce the use of red and processed meat, increase the use of locally and sustainably grown food, reduce food waste
Transport	Patients and personnel travel, shipment of medical equipment, supplies, and pharmaceuticals	Improve accessibility through public transportation and increase use of telehealth for follow-up appointments
Procurement and supply chain	Personal protective equipment, medical supplies, pathology and laboratory supplies	Encourage suppliers to estimate their carbon footprint and prioritize the use of low emission supply chains
Waste	Medical and food waste	Waste minimization and sustainable cancer care waste management



Nogueira LM, Yabroff KR, Bernstein A. Climate change and cancer. *CA Cancer J Clin.* 2020 Jul;70(4):239-244.

Eckelman MJ, Sherman J. Environmental impacts of the U.S. health care system and effects on public health. *PLoS One.* 2016;11:e0157014.

Sherman JD, MacNeill A, Thiel C. Reducing pollution from the health care industry. *JAMA.* 2019;322:1043-1044

# Reduce Healthcare System Emissions

## Food Purchases

### Environmentally Responsible Food

- Manufacture
- Shipment
- Waste

### Meat from ruminants

- Production of feed
- Processing
- Transport
- Methane emissions by ruminants
- Feedlot practices
- Antibiotic and Pesticide Use
- Waste

**Red meat is associated with colorectal cancer risk**



# Reduce Healthcare System Emissions

Promote better health outcomes



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Sherman JD, MacNeill A, Thiel C. Reducing pollution from the health care industry. *JAMA.* 2019;322:1043-1044

# What To Do?



*"I try to do my part."*

# Do Your Research

Health impact of climate change

## Evidence base

- Implement policies
- Environmental Reviews
- Impact Analysis

## Health Outcomes

- Energy infrastructure development
- Emissions standards
- Building codes
- Government subsidies



Jacobs-Shaw, R., What Standing Rock teaches us about environmental racism and justice. *Health Affairs*, 2017.

Johnston, J. and L. Cushing, Chemical Exposures, Health, and Environmental Justice in Communities Living on the Fence Line of Industry. *Curr Environ Health Rep*, 2020. 7(1): p. 48-57.

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“

Give me a lever long  
enough, and I shall move  
the world.

Archimedes

”

---

Thank you!

1.800.227.2345  
RELAY FOR LIFE  
cancer.org  
**WALKING ★ FIGHTING  
SURVIVING**  
Walk with us to finish the fight!  
relayforlife.org





[cancer.org](https://cancer.org) | 1.800.227.2345



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