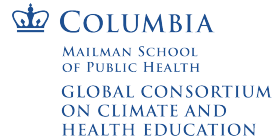


Caribbean Climate and Health Responders Course

Climate Change for the Health Professional - April 6, 2022

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Dean, School of Public Health, University of Pittsburgh



Learning Objectives

- Describe the difference between natural climate variability and long-term climate change
- Describe the measurement and evidence base of climate drivers.
- Distinguish between “climate” and “weather,” and between climate change and climate variability
- Explain the general mechanism of the greenhouse effect
- Explain the social dimensions of climate drivers, including population growth and economic growth
- Communicate the degree of scientific consensus on climate change.
- Explain the main health impacts of climate change, how the health sector contributes to climate change, and what health professionals can do

What is the Difference between Climate and Weather?

Climate is not the same as weather.

Weather: minute-by-minute variable condition of the atmosphere on a local scale.

Climate: a conceptual description of an area's average weather conditions and the extent to which those conditions vary over long intervals of time.



WEATHER

Tells you what to wear each day

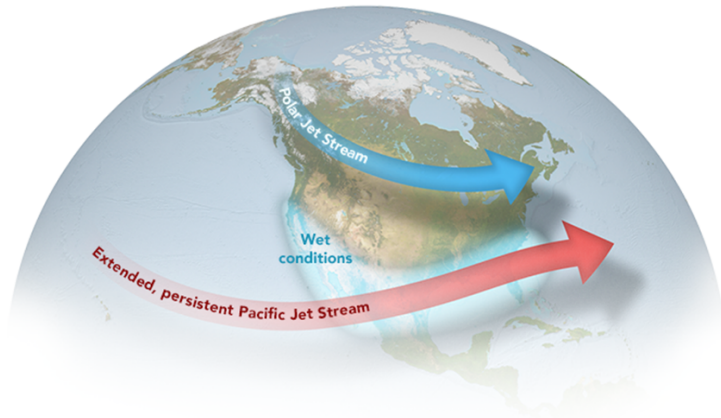


CLIMATE

Tells you what types of clothes to have in your closet



What is Natural Climate Variability?



El Niño Southern Oscillation

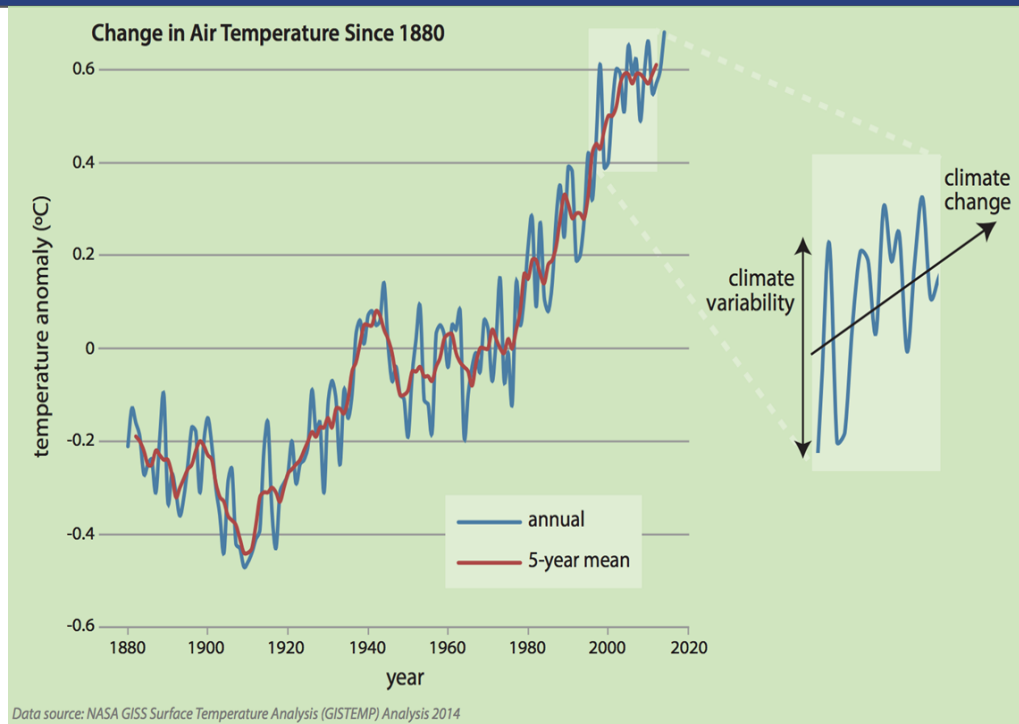
- Climate variability is how aspects of climate (such as temperature and precipitation) **differ from an average**.
- Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).
- Seasonal variations and multi-year cycles producing warm, cool, wet, or dry periods across different regions are a natural part of climate variability. These do not represent climate change.

Figure: <https://earthobservatory.nasa.gov/features/ElNino>

https://www.ipcc.ch/site/assets/uploads/2018/11/sr15_glossary.pdf

What is Climate Change?

- Climate change is a significant and persistent **change in an area's average** climate conditions or their extremes
- Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.



How Do We Know Climate Change is Happening?

- Based on evidence from tree rings, other natural records, and scientific observations made around the world, Earth's average temperature is now warmer than it has been for at least the past 1,300 years.
- **Average temperatures** have increased markedly in the past 50 years, especially in the North Polar Region.
- Natural processes driving Earth's long-term climate variability do not explain the rapid climate change observed in recent decades.



Satellite

Observing Earth's Global Climate

Snow Cover

Precipitation



Solar Radiation

Sea Ice

Wind

Temperature

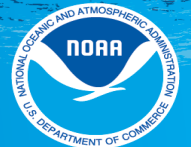
Sea Level

Humidity

Ground Stations

Sea Surface Temperature

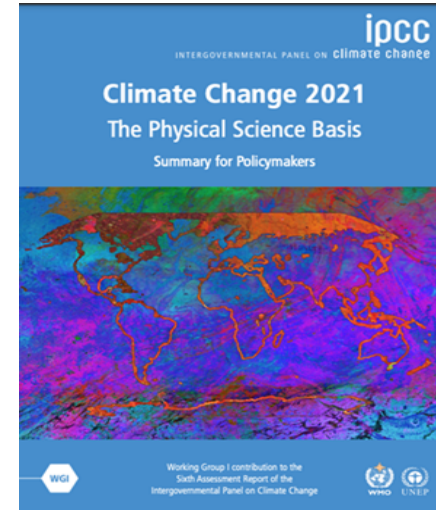
Ocean Heat Content



NOAA National Centers for Environmental Information

What are some Impacts of Climate Change?

- The world is experiencing warmer temperatures, rising rainfall and storms, glacial retreat, sea level rise, shifting climate zones.
 - These changes are here and happening now
 - Many changes are irreversible and tipping points are increasingly likely
- Severe health impacts will increase
 - Extreme heat thresholds relevant to agriculture and health are projected to be exceeded more frequently

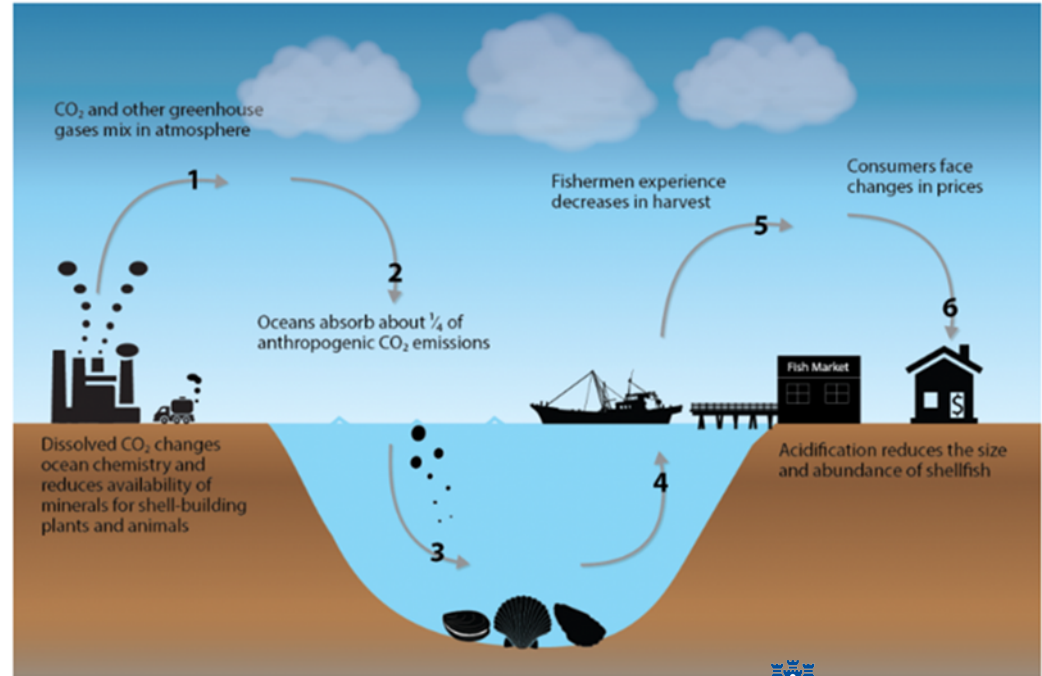


IPCC, 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., et al. (eds.)]. Cambridge University Press.

Oceans and Health

- Threats/decrease of fish/fisheries due to rise in SST & SLR and extreme weather events
- Coastal erosion (SST, SLR, EWE)
- Coral bleaching (SST)
- Blooming of algae (SST)
- Marine disease outbreaks (SST and salinity)
- Ocean acidification → impact on shellfish (↓ size and number)

Figure 1. Ocean Acidification Impact Pathway for Shellfish

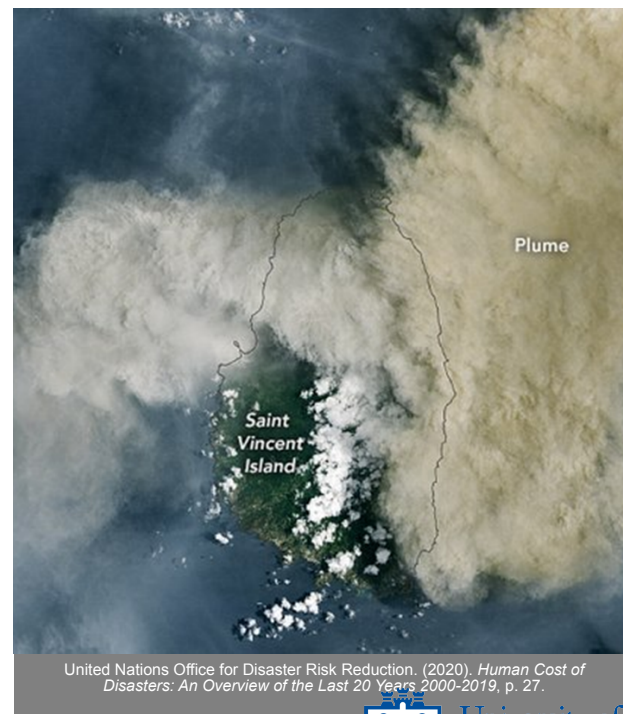




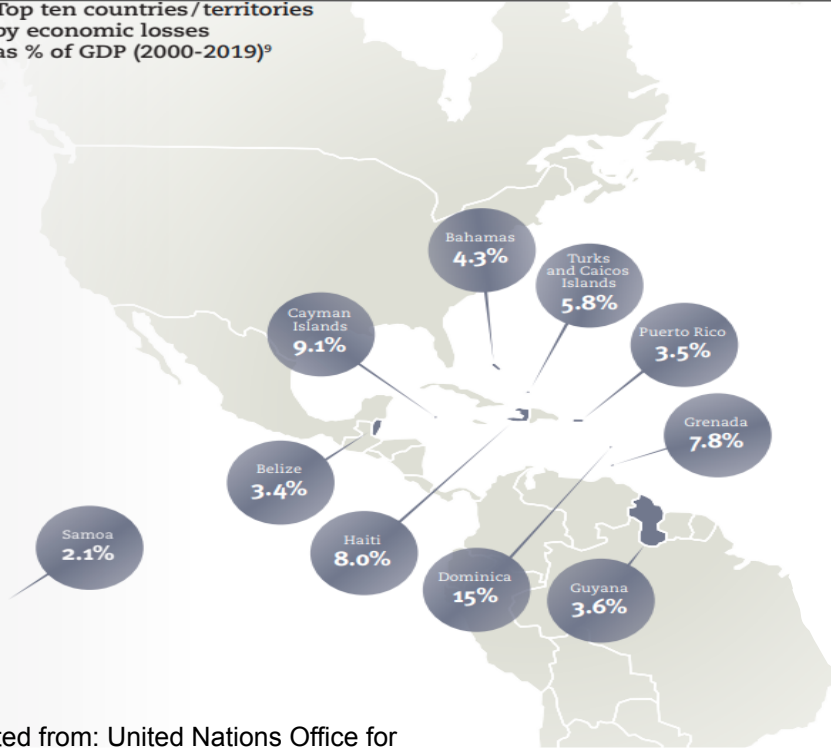
Pedersen Glacier, at Aialik Bay in Alaska's Kenai Mountains, in 1917 (left) and 2005 (right).

What are some Impacts of Climate Change?

- Threat of climate-related disasters has increased, 2000-2019
 - 4.03 billion people affected (41% from flooding, 35% drought, 18% storms)
 - 1.23 million died (58% from earthquakes, 16% storms, 13% extreme temperature)
- Caribbean countries have felt the brunt of the impact
 - Cuba and Dominica are among the top 10 countries with highest share of affected persons after standardization to population size
 - Haiti earthquake (2010) was the 2nd deadliest disaster of the last 20 years



Top ten countries / territories
by economic losses
as % of GDP (2000-2019)^a



Economic Impact

- Disasters have a relatively high impact on smaller economies, e.g., storms on small islands
- Of the top 10 countries by economic losses (% of GDP), 9 were island nations in the Caribbean region

Adapted from: United Nations Office for Disaster Risk Reduction. (2020). *Human Cost of Disasters: An Overview of the Last 20 Years 2000-2019*, p. 27.

Observed Impacts on Small Islands

- Small islands are increasingly affected by:
 - Increases in temperature
 - A larger proportion of the most intense tropical cyclones
 - Storm surges
 - Droughts
 - Changing precipitation patterns
 - Sea-level rise
 - Coral bleaching
 - Invasive species

All are already detectable across both natural and human systems.

What is the Scientific Consensus on Climate Change?

- The Intergovernmental Panel on Climate Change (IPCC) first stated there was scientific consensus on climate change in 2001
- “Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.” (2014 IPCC Report, p. 4)
- “Small island are increasingly affected by increases in temperature.”

What have Other Scientists Found?

- A recent study determined 99% consensus on human-caused climate change in a randomized subset of 3000 climate-related papers published since 2012
(*Lynas et al, 2021*)



What are Physical Climate Drivers?

Natural drivers

- **Solar Irradiance:** Changes in solar irradiance directly impact the climate system because the irradiance is Earth's primary energy source
- **Volcanoes:** Most volcanic eruptions are minor events effects of emissions confined to the troposphere and only lasting for weeks to months. In contrast, explosive volcanic eruptions inject substantial amounts of sulfur dioxide (SO₂) and ash into the stratosphere, which lead to significant short-term climate effects

What are Physical Climate Drivers?

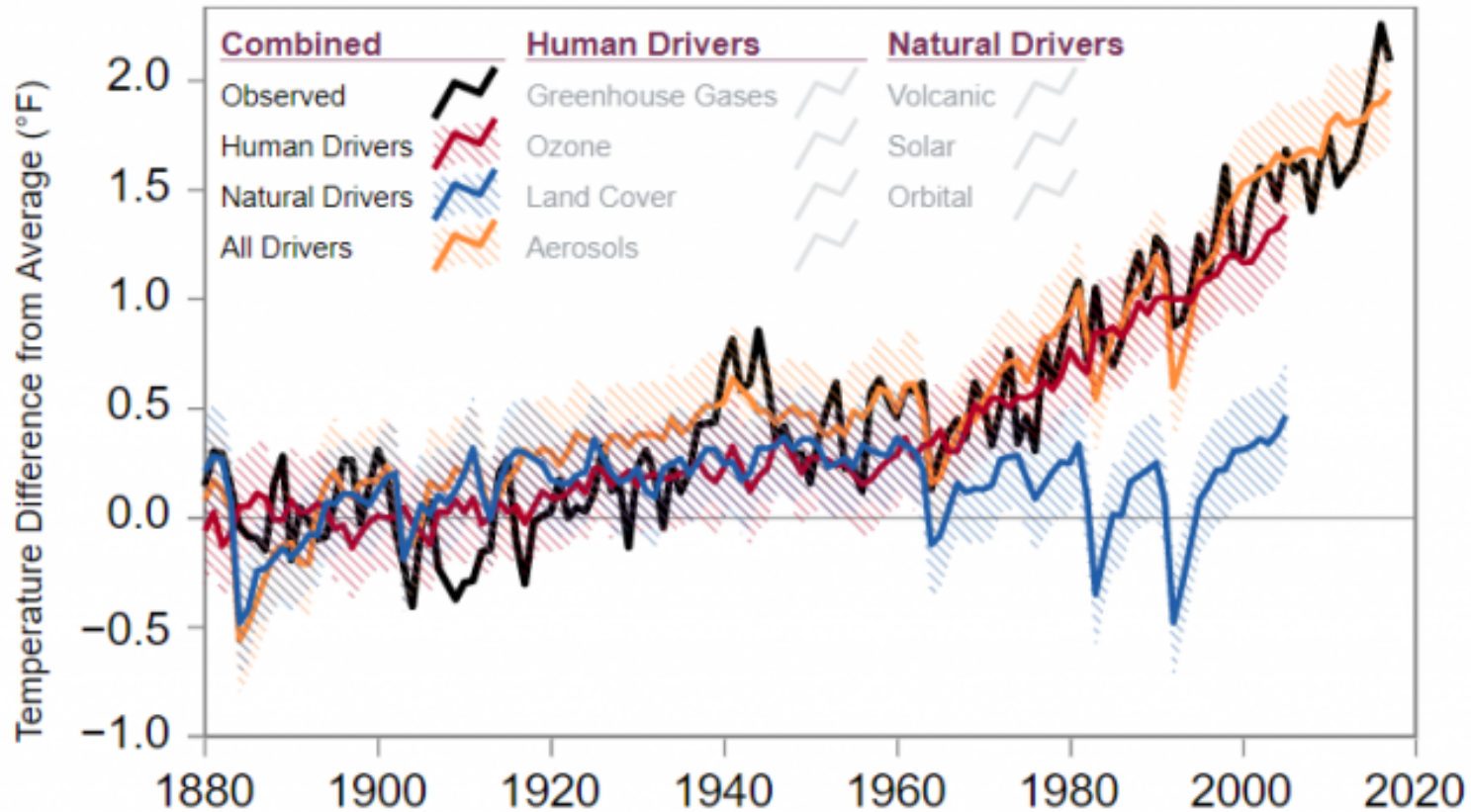
Anthropogenic drivers include:

- Well-mixed greenhouse gases (WMGHGs)
 - Carbon dioxide (CO₂)
 - Methane (CH₄),
 - Nitrous oxide (N₂O)

- Short-lived climate forcers (SLCFs)
Include methane, some hydrofluorocarbons [HFCs], ozone, and aerosols

- Land cover changes (cause changes in albedo or the ability of surfaces to reflect heat from the sun)

Human and Natural Influences on Global Temperature

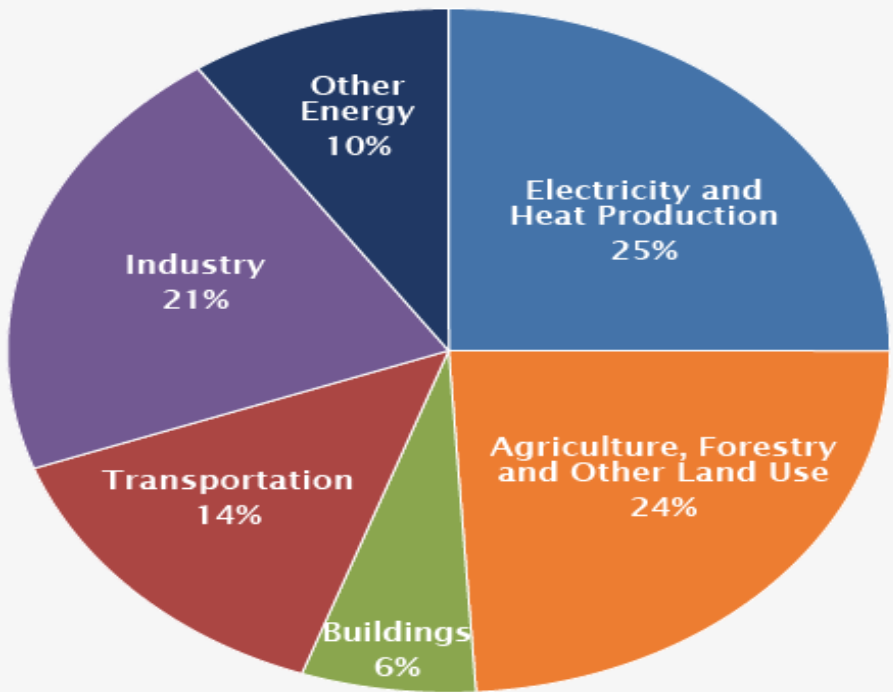


Greenhouse Effect Normal CO₂

Greenhouse Effect: Rampant CO₂



Global Greenhouse Gas Emissions by Economic Sector



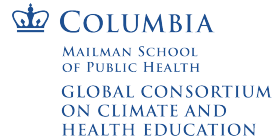
University of
Pittsburgh
School of Public Health

[IPCC \(2014\)](#)

Zoom Poll Question 1

What economic sector has the highest greenhouse gas emissions in your country?

- a) Agriculture, forestry or other land use
- b) Buildings
- c) Electricity and heat production
- d) Industry
- e) Transportation
- f) Other



What are the Social “Drivers” of GHG Emissions?

- Drivers are “elements that directly or indirectly contribute to GHG emissions” (p. 364)
- These elements or activities indicate an *association* between human activity and changes in global GHG emissions
- Human activities are complex and interconnected. Identifying the exact cause-and-effect of GHG emissions is difficult. Thus, we use the term “driver” and not “causes”

Social Drivers of Climate Change

This presentation will cover:

- Economic growth
- Population growth
- Inequality
- Infrastructure

There are others you can investigate:

- Land-use and land cover change
- Technology

Economic Growth

- Globally, economic growth (GDP per capita) and development are major drivers of GHG emissions
- Worldwide GDP per capita grew 100% between 1970 and 2010
- Countries with higher income per capita tend to have higher energy use per capita
- As they decarbonize, countries can decouple economic growth from CO₂ emissions

Per Capita Carbon Footprint vs. Per Capita GDP

S. Fiske, K. Hubacek, A. Jorgenson, J. Li, T. McGovern, T. Rick, J. Schor, W. Solecki, R. York, A. Zycherman. (2018). Drivers and responses: Social science perspectives on climate change, part 2. Washington, DC: USGCRP Social Science Coordinating Committee.

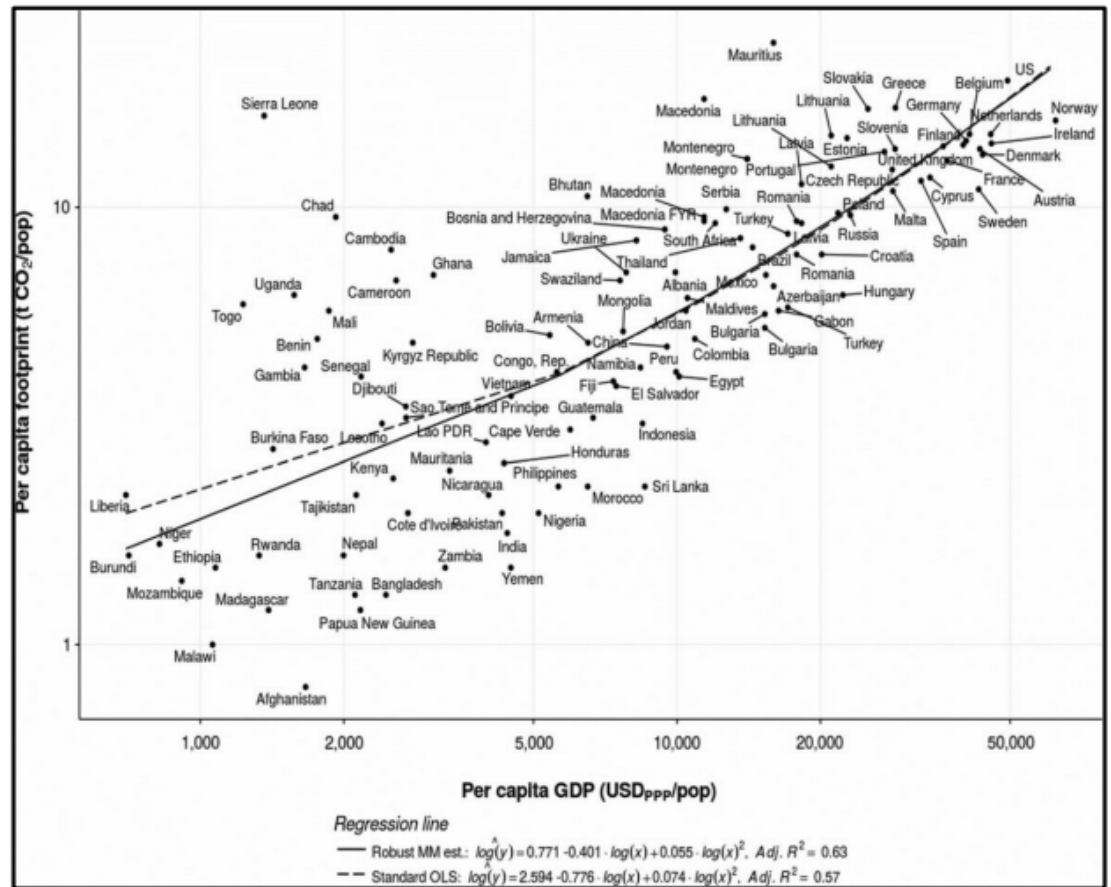


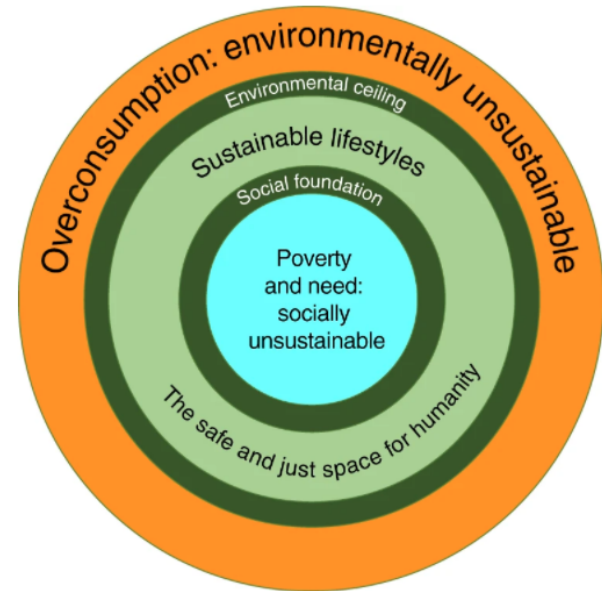
Figure 1. Per capita carbon footprints versus per capita GDP in \$PPP. Both OLS and robust MM regressions are presented, due to the number of outliers. The robust regression corroborates the OLS results. Source: Hubacek, Baiocchi, Feng, Muñoz Castillo et al. (2017, p.366, fig.3)

Economic Growth: Consumption

- Production is tied to consumer behavior
- Buying something typically implies complex supply chains and production activities that emit GHG (as a counter to this: “buy local”)
- Consumers have little control over economic systems, supply chains, infrastructure, trade relations etc., but there is a case for reducing consumption
- Policy could push companies and consumers in more climate-friendly or “green” directions, but there has been limited use

Fig. 2: The safe and just space for humanity.

From: [Scientists' warning on affluence](#)



Sustainable lifestyles are situated between an upper limit of permissible use (“Environmental ceiling”) and a lower limit of necessary use of environmental resources (“Social foundation”) (figures from ref. ⁴⁹ and ref. ⁸⁴ combined and adapted).

Wiedmann, T., *et al.* Scientists' warning on affluence. *Nat Commun* 11, 3107 (2020); Thøgersen, J. Consumer behavior and climate change: consumers need considerable assistance, *Current Opin in Behav Sci*, 42, 2021, 9-14.

Consumer Change

- Eating more plant-based protein is an example of a change in consumer behavior
- Has health co-benefits

TAKE A BITE* OUT OF CLIMATE CHANGE



**Plant-based*



@ MeatlessMonday

MeatlessMonday

Population Growth

- Between 1970 and 2010, world population grew 87%
- Most population growth was in Asia, Latin America and Africa
- More people = more emissions
- Age structure matters with working-age population having the most emissions

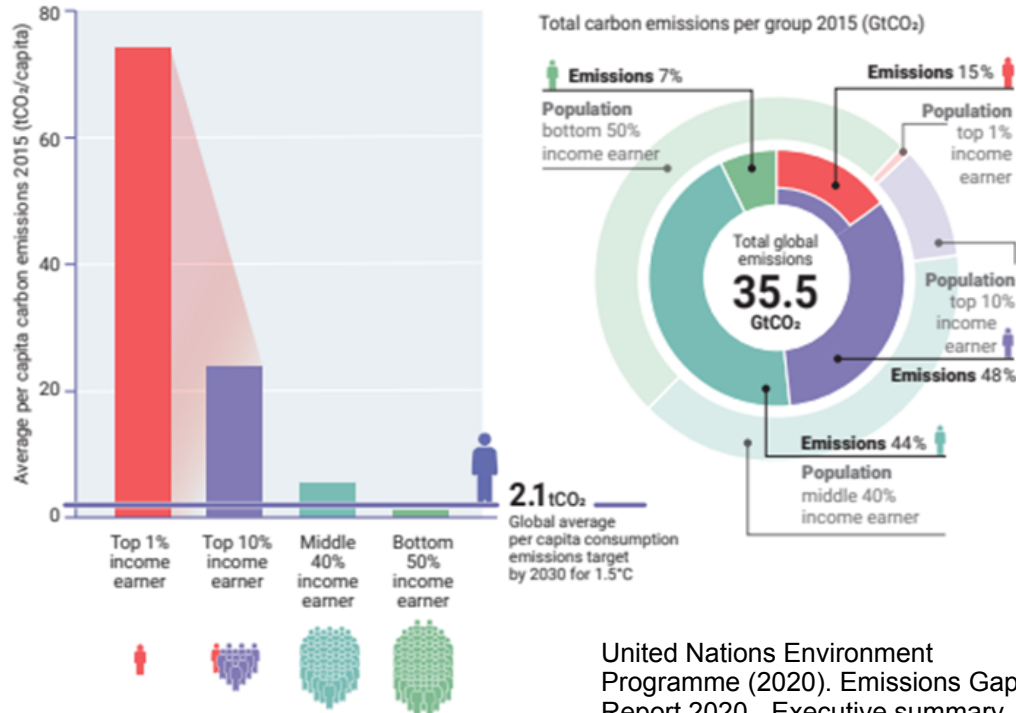
BUT...

- Emissions increase *per capita* depends upon location, income, and energy resources

Blanco G., et al, 2014: Drivers, Trends and Mitigation. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; United Nations Environment Programme (2020). Emissions Gap Report 2020 - Executive summary. Nairobi.

Inequality

Figure ES.8. Per capita and absolute CO₂ consumption emissions by four global income groups for 2015



Emissions of the richest 1% of the global population account for more than twice the combined share of the poorest 50%

Infrastructure

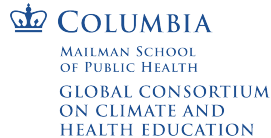


- Includes transportation, roads and bridges, buildings, water supply, irrigation, wastewater treatment, power, telecom etc.
- Physical infrastructure decisions have long-term effects on emissions; locked-in and costly to switch out
- Infrastructure affects consumer behavior; e.g., lack of public transport encourages use of private vehicles
- Requires investment in low-carbon infrastructure – renewable energy, urban public transport projects, and railways

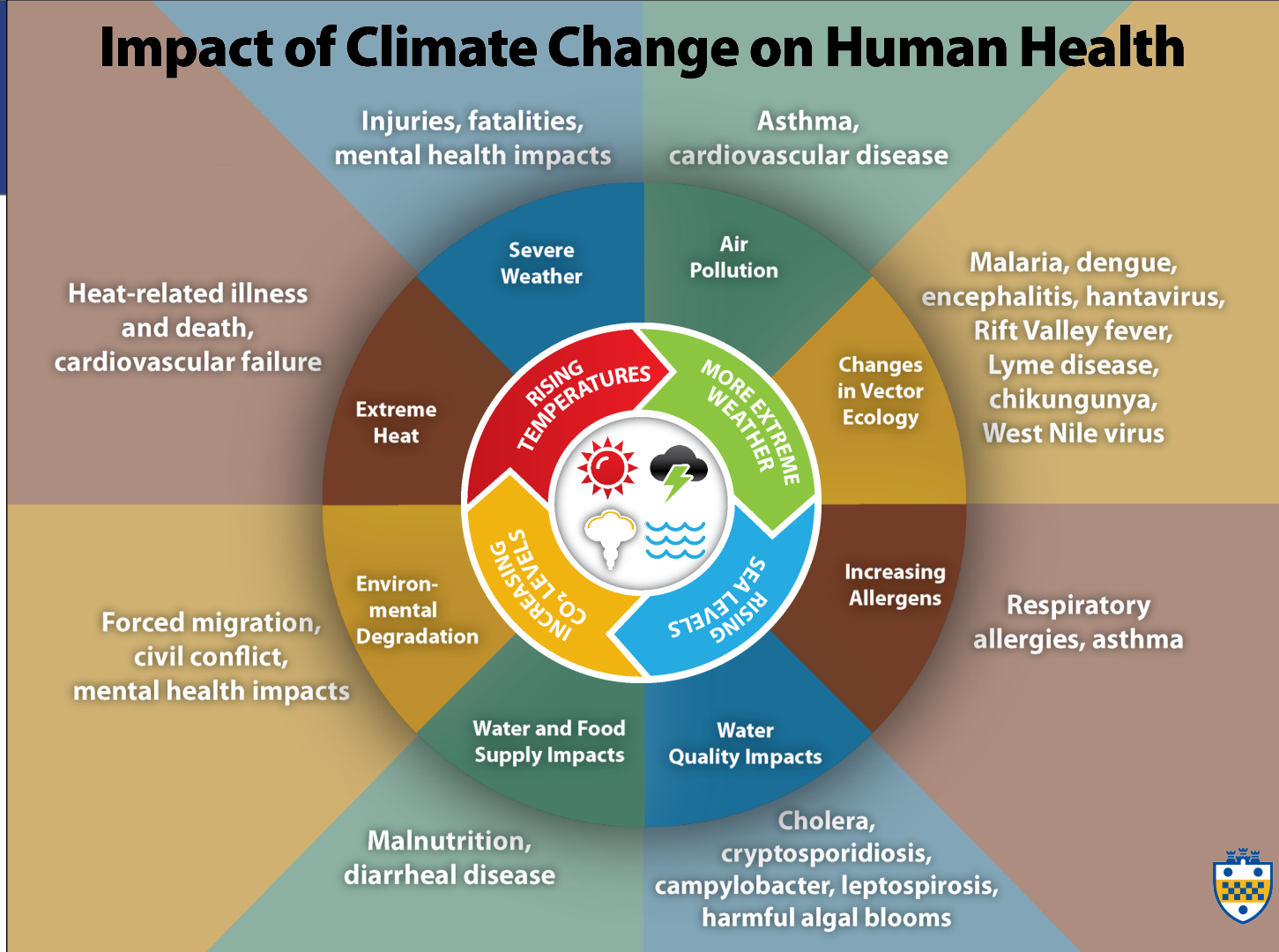
Zoom Poll Question 2

What type of low carbon infrastructure is most needed in your country?

- a) Renewable energy (solar, wind, hydropower)
- b) Cargo trains/railways
- c) Public transport options (trains, light rail, bicycle lanes)
- d) Green buildings



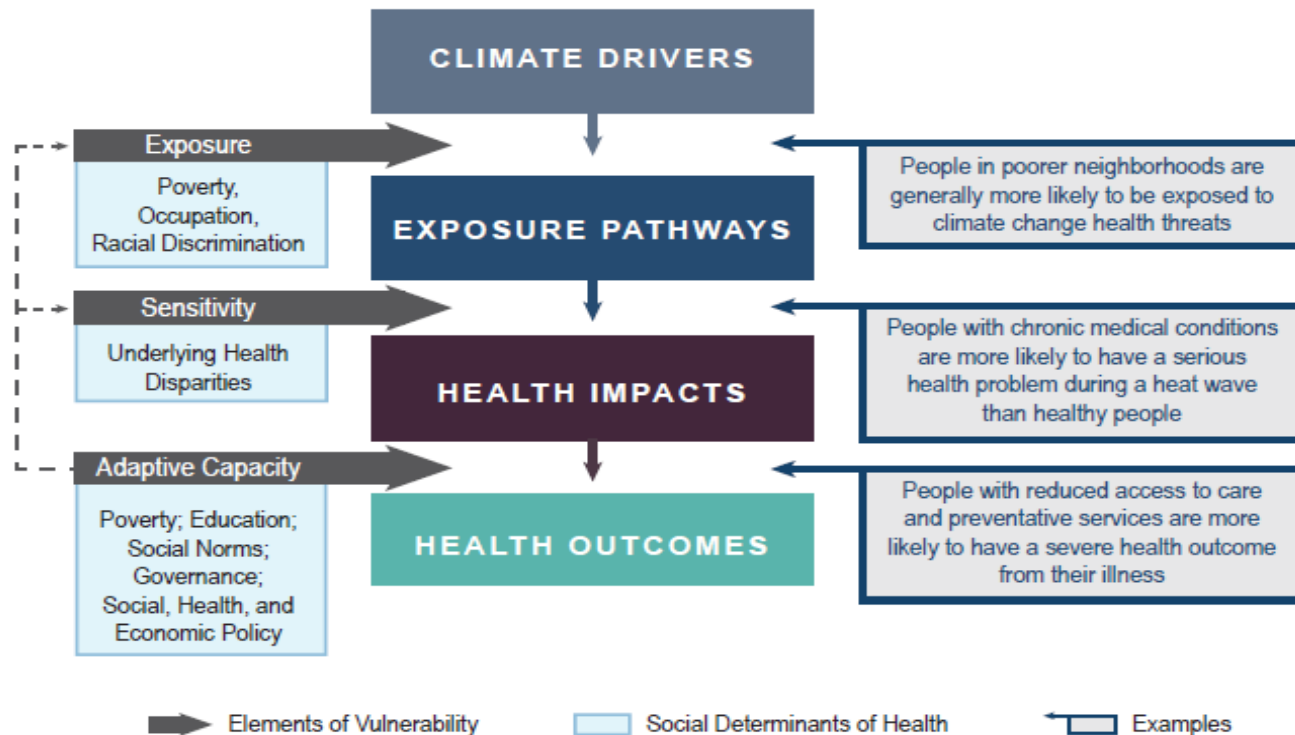
Impact of Climate Change on Human Health



Source: CDC,
[https://
www.cdc.gov/
climateandhealth/
effects/
default.htm](https://www.cdc.gov/climateandhealth/effects/default.htm)

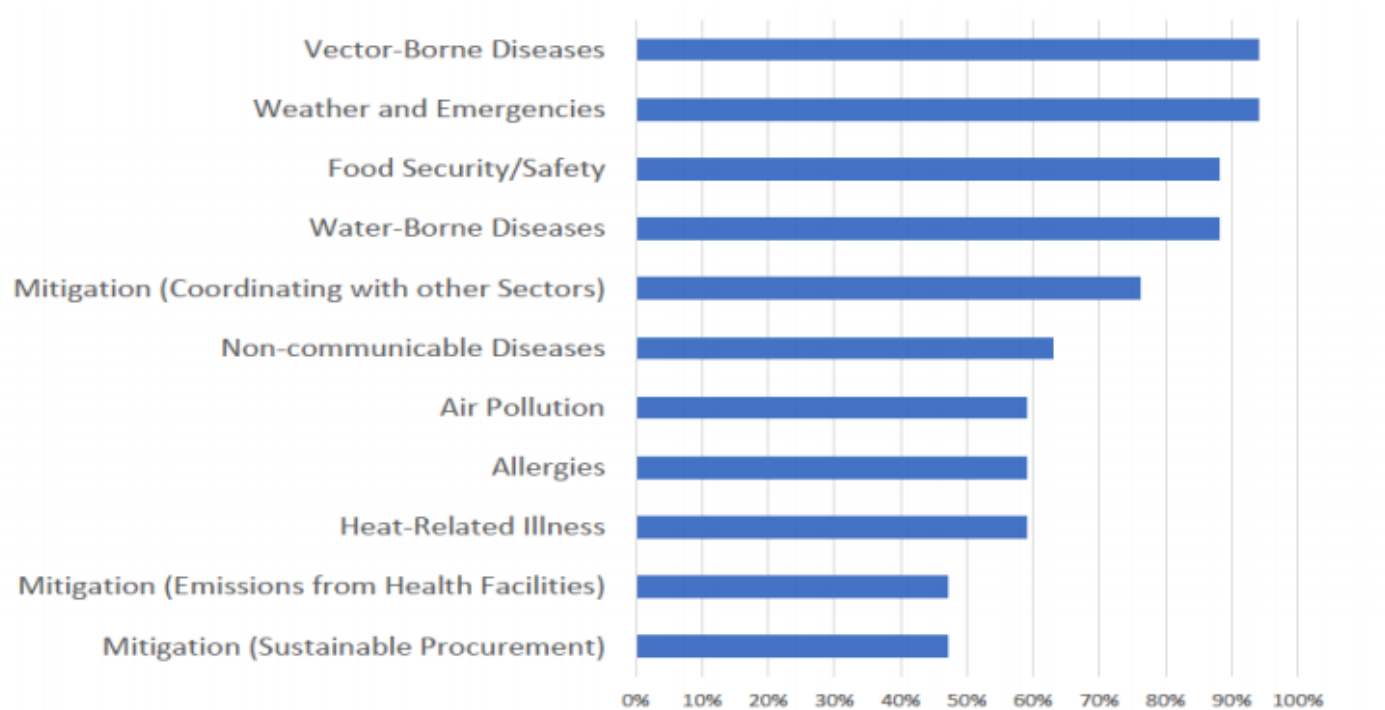


Intersection of Social Determinants of Health and Vulnerability



Source: Gamble, et al., 2016: Ch. 9: Populations of Concern. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. U.S. Global Change Research Program, Washington, DC, 247–286. <http://dx.doi.org/10.7930/J0Q81B0T>
<https://health2016.globalchange.gov/populations-concern>

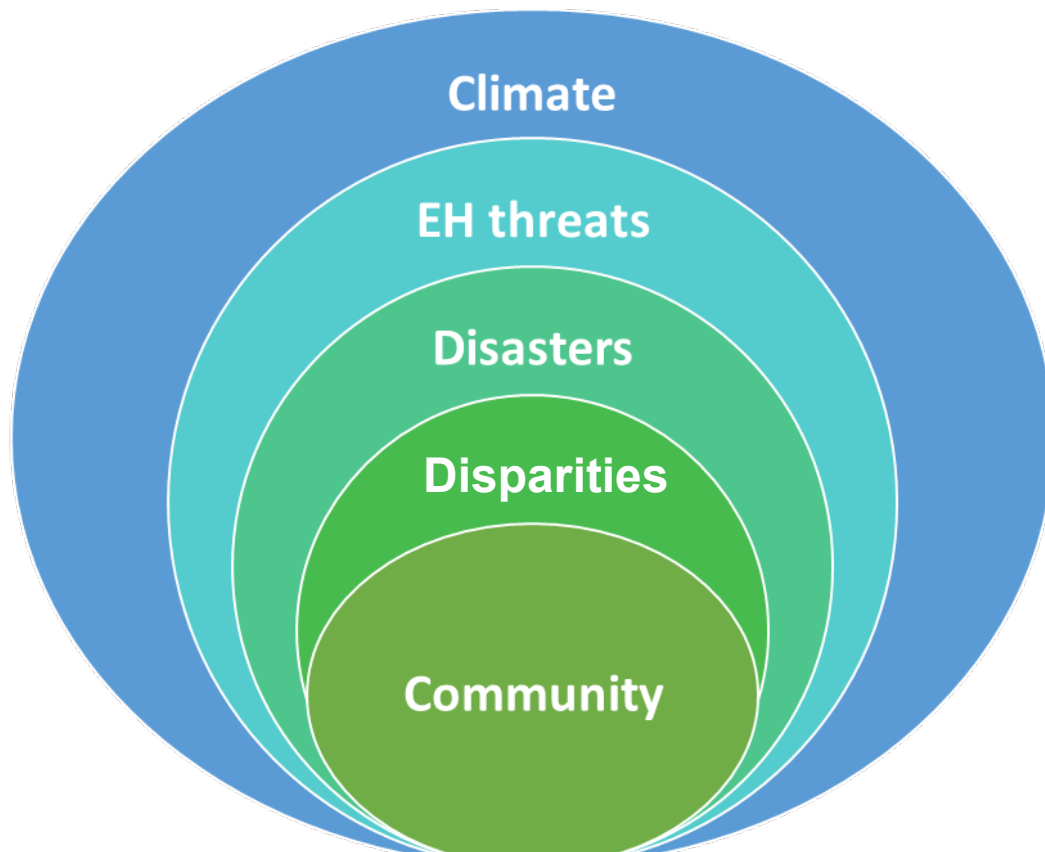
PAHO Country Survey on Health and Climate Change: Topics rated as “Extremely Important” or “Important” (n=18)



Climate and Health in the Caribbean Region

- Caribbean countries and other Small Island Developing States contribute little to GHG emissions driving climate change, but they experience disproportionate impacts of climate change sooner and more severely
- Triple threat in the region:
 - disproportional high burden of non-communicable diseases
 - epidemic and endemic infectious and zoonotic diseases
 - fragile health infrastructure to address occurring health challenges

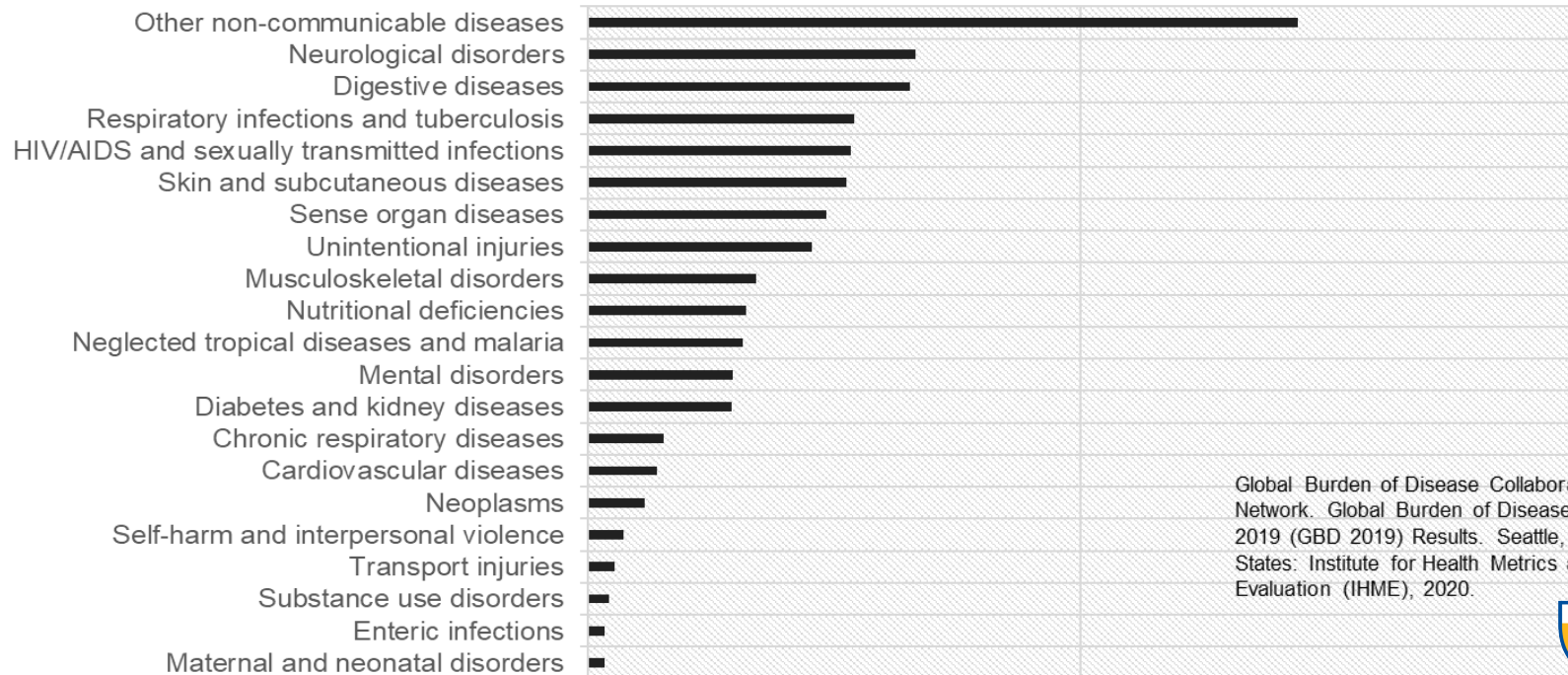
Climate and Community Vulnerability



Disparate Disease Burden in the Caribbean

rate per 100K, 2019

0 50,000 100,000



Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2020.

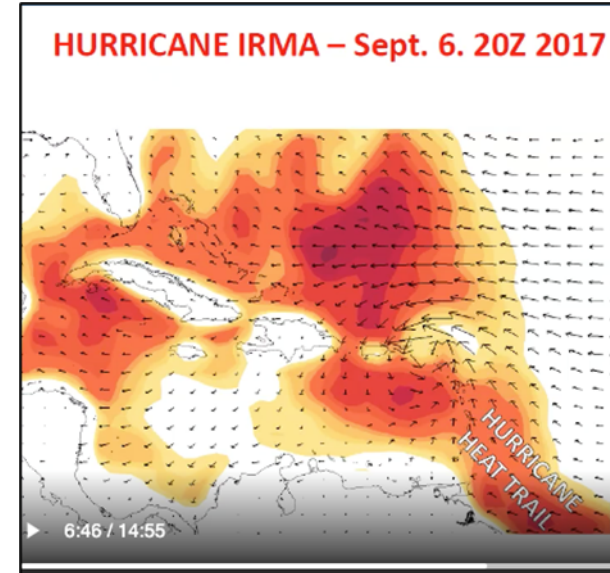


Climate and Health Pathways

- Pathways are complex and may lead to direct or indirect health effects. Some exposures may lead to multiple pathways.
- Heat > Exacerbation of NCDs (e.g., CVD, respiratory and renal disease)
 - Directly via air pollution and extreme temperatures (increased mortality, emergency presentations, hospital admissions)
 - Indirectly via diet (decreased access to healthy foods, changing agricultural yields)
- Drought
- Saharan dust > Exacerbation of NCDs
 - Directly via air pollution

Hurricane Heat Trail Effect

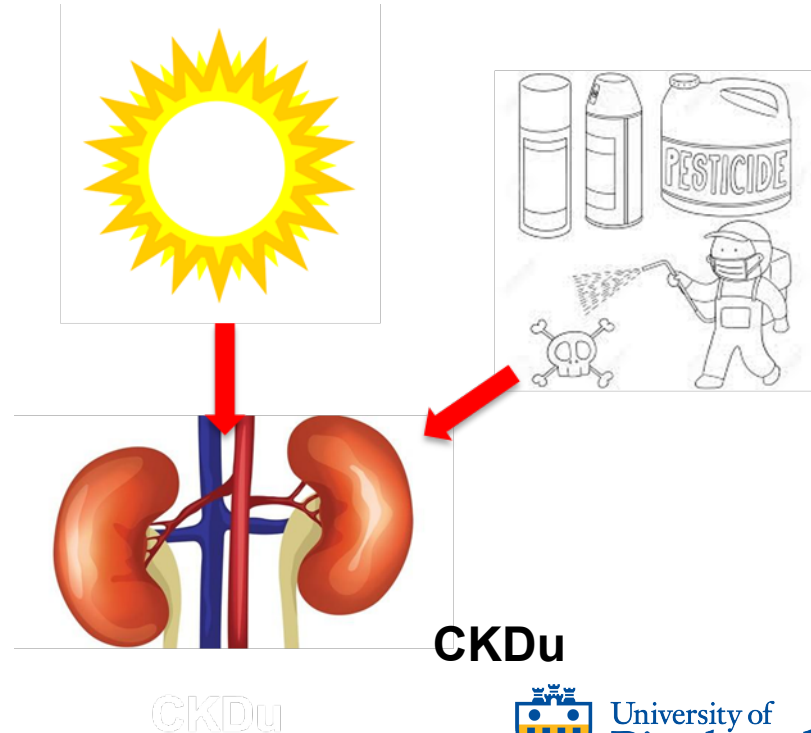
- Heat waves occur differently from island to island and are caused by local scale circulation patterns.
- Hurricane Irma in Barbados
 - After the passage of a major hurricane, warm and humid southerly winds can lead to emergence of heat waves in the Eastern regions.
 - Additionally, overnight lows are warmer than normal
- Hurricane Maria in Puerto Rico
 - Background temperature was observed to be a factor
 - Since it was already abnormally warm before the hurricane, the climatology signal of the heat trail effect was not strong
- Heat waves and limited night-time cooling can compound the health effects of hurricanes.



Theodore Allen et al., The Hurricane Heat Trail Effect on Caribbean Heat Waves. 2020, American Meteorological Society Annual Meeting. Video Recording.

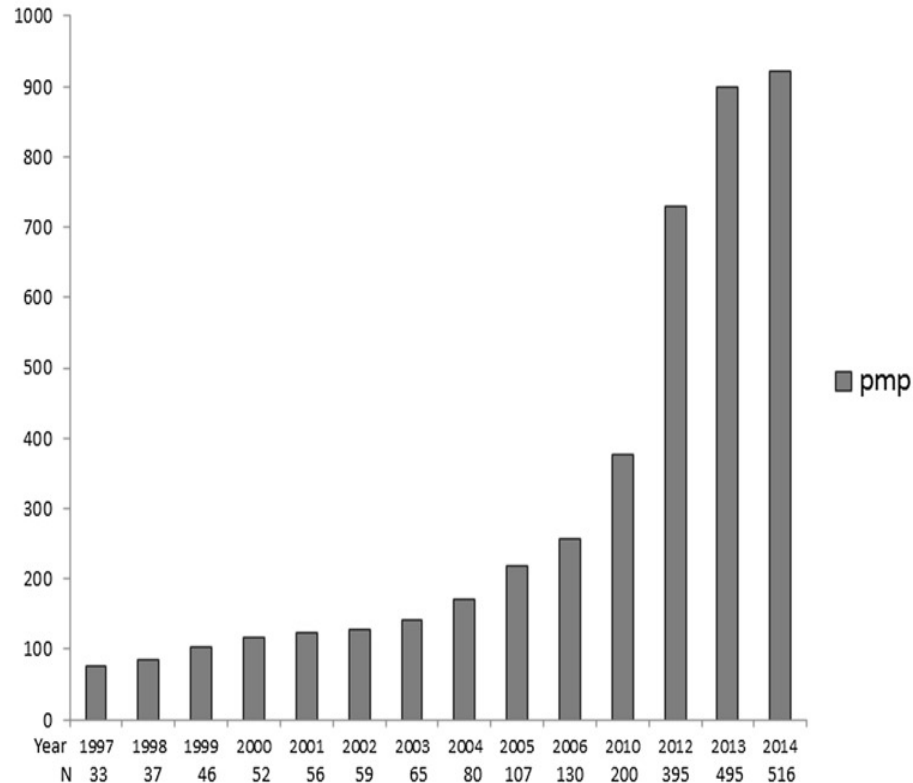
Heat Stress and AG Workers

- Heat stress: mostly cardio-vascular and renal consequences
- Renal consequences: repeated acute kidney injury leading to chronic kidney disease (CKD) over time
- Chronic kidney disease with dialysis: on the rise (e.g., in Suriname)
 - ❖ Mostly caused by DM and/or hypertension
 - ❖ CKD with unknown origin (CKDu); may be related to heat stress
 - ❖ No research has been conducted on this association in the Caribbean
- Occupational pesticide exposure: double whammy on kidney disease



Hemodialysis

Increase in dialysis patients in Suriname

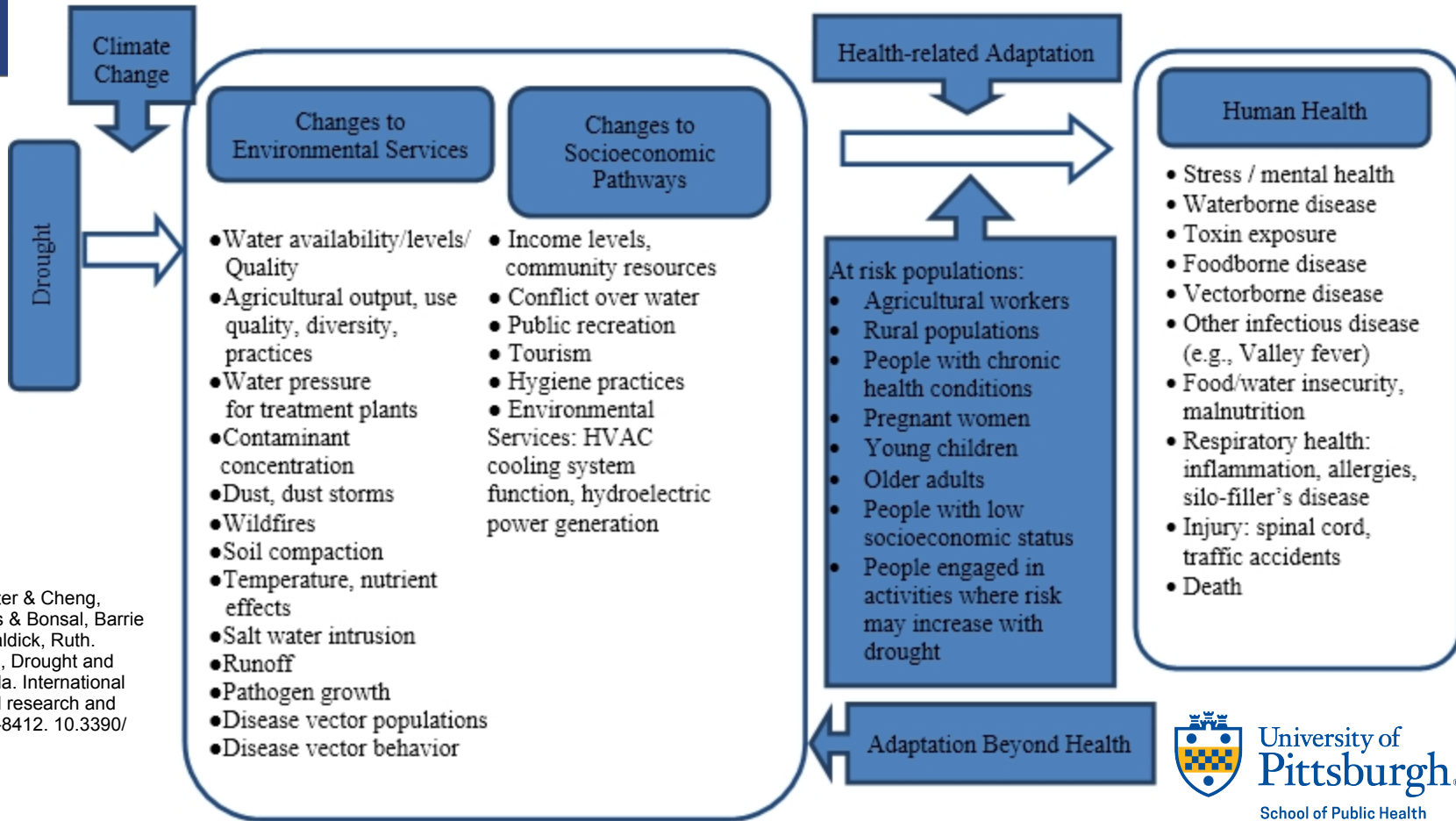


2019
750

Nannan Panday, R., Haan, Y., Diemer, F. et al. Intern Emerg Med (2019) 14: 249.
<https://doi.org/10.1007/s11739-018-1962-3>



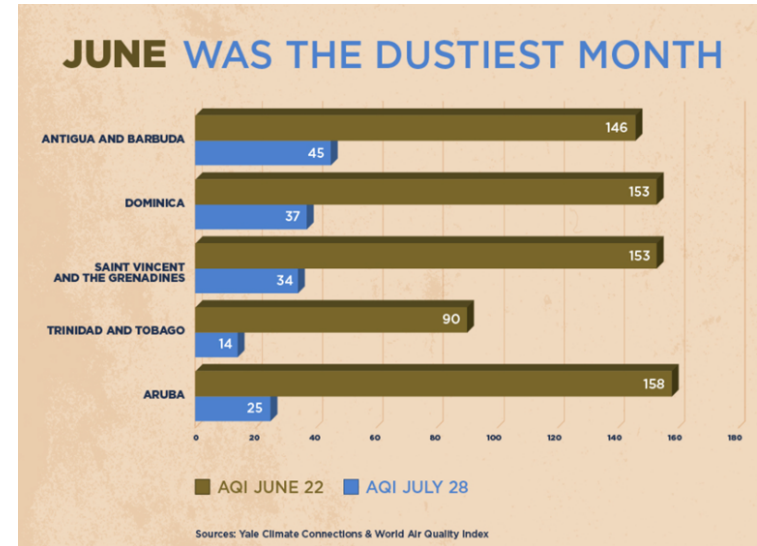
Drought Pathway



Yusa, Anna & Berry, Peter & Cheng, June & Ogden, Nicholas & Bonsal, Barrie & Stewart, Ronald & Waldick, Ruth. (2015). Climate Change, Drought and Human Health in Canada. International journal of environmental research and public health. 12. 8359-8412. 10.3390/ijerph120708359.

Early Warning System for Sahara Dust

- Largest Saharan dust storm in Summer 2020
- Irritates eyes, ears, noses, and throats, aggravates lung function sensitivities, and reduces visibility
 - Can exacerbate covid-19 symptoms
- Two days of unhealthy air conditions in Puerto Rico
- Early warning system was in place and the incoming dust was communicated in the news and national forecasts
 - Including Facebook live event with ~300,000 viewers
 - PR Department of Health Office issued public health recommendations
 - Vulnerable groups – elderly, children under 5, pregnant women, and people with asthma or other respiratory or dermatological issues



COMMUNITIES OF COLOR

Some communities of color living in risk-prone areas face cumulative exposure to multiple pollutants.

Adaptation plans that consider these communities and improve access to healthcare help address social inequities.

OLDER ADULTS

Older adults are vulnerable to extreme events that cause power outages or require evacuation.

Checking on elderly neighbors and proper emergency communication can save lives.

CHILDREN

Children have higher risk of heat stroke and illness than adults.

LOW INCOME COMMUNITIES

Low income families are at risk of physical and mental illnesses during flooding and in crowded shelter conditions.

Comprehensive disaster management can improve resiliency for people with limited resources.

Adults can lessen risk by monitoring exertion and hydration.

How Does the Health Sector Impact Climate Change?

- Health care's climate footprint is 4.4% of global net emissions
- Investments to “greening” health care facilities – such as the use of solar panels, energy efficient equipment and waste management – must be made. Globally, only about 0.5% of multilateral climate finance has been attributed to health projects.
- Health care facilities also need to be safe and remain operational during and soon after disasters. In the Americas, 67% of health facilities are located in areas at risk of disasters.

Smart Hospitals

- Health care facilities are 'smart' when they link their structural and operational safety with green interventions, at a reasonable cost-to-benefit ratio.
- PAHO Smart Hospitals Toolkit

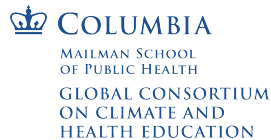
A practical guide for hospital administrators, health disaster coordinators, health facility designers, engineers and maintenance staff to achieve Smart Health Facilities by conserving resources, cutting costs, increasing efficiency in operations and reducing carbon emissions



Zoom Poll 3

What are the top 3 adverse health effects of climate change in your country of work?

- a) Vector borne diseases
- b) Respiratory diseases (including asthma and allergies)
- c) Foodborne diseases and nutrition
- d) Mental health
- e) Cardiovascular disease
- f) Weather-related injuries or mortality
- g) Waterborne diseases
- h) Heat effects



What Can Health Professionals Do?

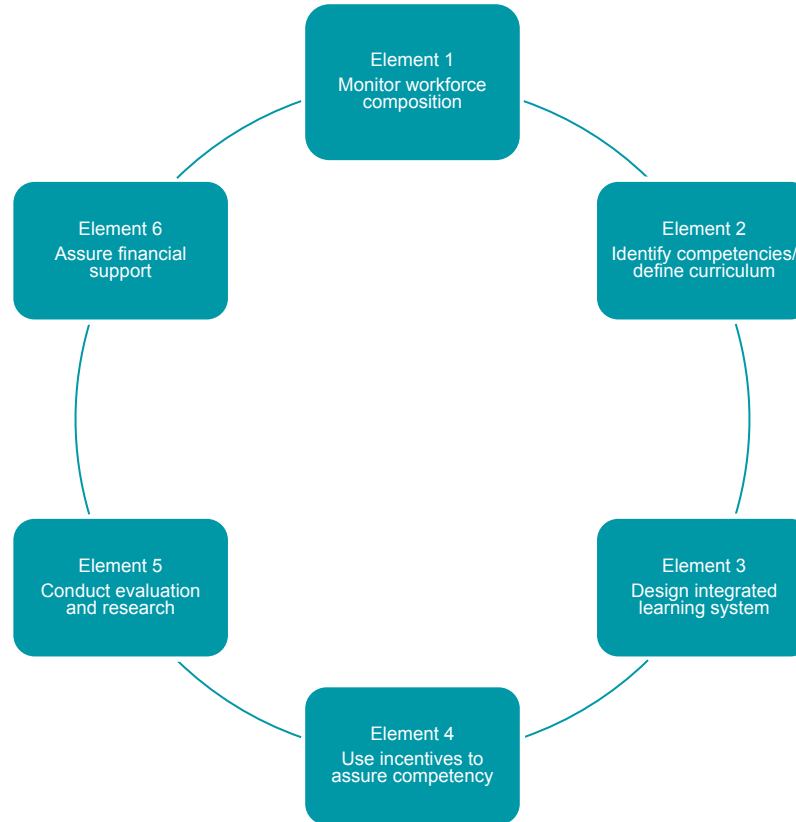
- Retool patient education
- Serve as content experts and trusted messengers
- Public health agencies must be involved in preparedness and prevention
- Expand public health and medical education to include climate change
- Conduct regional surveillance studies and analyses of increases in disease burden, injury, and related health care costs
- Serve as advocates for adaptation and mitigation action
- Highlight individual stories of those affected by climate change
- Identify vulnerable groups who might need advice on health management and protective behaviors

Kreslake JM, Sarfaty M, Roser-Renouf C, Leiserowitz AA, Maibach EW.

The Critical Roles of Health Professionals in Climate Change Prevention and Preparedness.

Am J Public Health. 2018;108(S2):S68-S69. doi:10.2105/AJPH.2017.304044

Strategic Elements for Public Health Workforce Development



CLIMATE CHANGE FOR HEALTH PROFESSIONALS

A pocket book

“With this quick reference guide, providers can easily recognize diseases and side effects related to climate change, implement appropriate management and provide guidance to exposed populations, provide up-to-date information on the relationship between the adverse effects of certain drugs and the worsening of climate-sensitive health conditions, and determine the possible consequences of climate change for health services.”

<https://iris.paho.org/handle/10665.2/52930>

Caribbean Health Climatic Bulletin



Caribbean Health Climatic Bulletin Vol 3 | Issue 1 March 2019

This Bulletin is a joint effort between the Caribbean Public Health Agency (CARPHA), the Pan American/World Health Organization (PAHO/WHO) and the Caribbean Institute for Meteorology and Hydrology (CIMH). It aims to help health professionals identify and prepare health interventions for favorable or inclement climate conditions in the Caribbean. The period covered is March to May 2019. It is recommended that health stakeholders should use the combination of monitoring (November 2018 - January 2019) and forecast (March - May 2019) climate information presented in this Bulletin in tandem with weather forecasts (1-7 days). This suite of information is intended to guide strategic and operational decisions related to health interventions and the management of health care systems.

What are the Key Climate Messages for March to May 2019?

- Climatically, March to May forms the **second half of the Caribbean Dry Season** in Belize and the Caribbean Islands, characterised by relatively few wet days and a small number of wet spells, but many dry days and quite a few dry spells. That said, the intensity of heavy showers increases towards May, especially in the Greater Antilles. Consequently, despite being very low in March, the potential for flooding increases in April and May (*high confidence*). In the coastal Guianas, a steady increase in flooding potential should manifest by May which is the start of their primary wet season (*high confidence*).
- Whereas in March **extreme wet spells** are virtually non-existent across the region, the chance for such spells increases steadily from April onwards. Extreme wet spells may coincide with thunderstorms and high winds, and may result in **flash floods**, land slippage, power outages and possible contamination of food and water supplies.
- Moderate to severe **drought** has started impacting many areas in the Caribbean. Notably, Barbados, parts of Belize, much of Hispaniola, much of the Leeward Islands, Saint Lucia, St. Vincent and Tobago have seen long term drought developing. Short term drought is seen in the ABC Islands, northern Barbados, south-eastern Cuba, much of Hispaniola, St. Vincent, Trinidad and Tobago. This is, in part, due to a developing weak El Niño. That said, extreme to exceptional drought such as that experienced by many territories between 2014 and 2016, when El Niño was particularly strong, is unlikely.
- Regionally, **rainfall totals** from March to May are forecast to likely be at least as dry as usual in the ABC Islands, Belize and the Lesser Antilles, but likely the usual or wetter in Cayman, Cuba and eastern portions of the Guianas (*medium confidence*).
- **Short term drought** (on a 3-6 months timescale) is currently evolving in Barbados, parts of Belize, Dominica, Grenada, Guyana, St. Vincent, Trinidad & Tobago (*high confidence*). Such conditions increase the potential for bush fires and may temporarily increase smoke and soot concentrations in the air.
- **Long term drought** (on a 12 months timescale), which affects the largest water reservoirs, is evolving in Antigua, west-central Belize, Cayman, N & S Dominican Rep., NE Guyana, St. Kitts, Trinidad & Tobago, Windward Islands (*high confidence*), and may develop in most other areas of the Caribbean by the month of May (*medium confidence*).
- Night-time and day-time **temperatures** in the Caribbean are set to increase as the Caribbean approaches its annual heat season which starts in May, with the exception of the Guianas. Night-time and day-time temperatures are forecast to be at least as warm as usual (*medium to high confidence*) and, from April onwards, may locally feel uncomfortable at times due to dry heat.

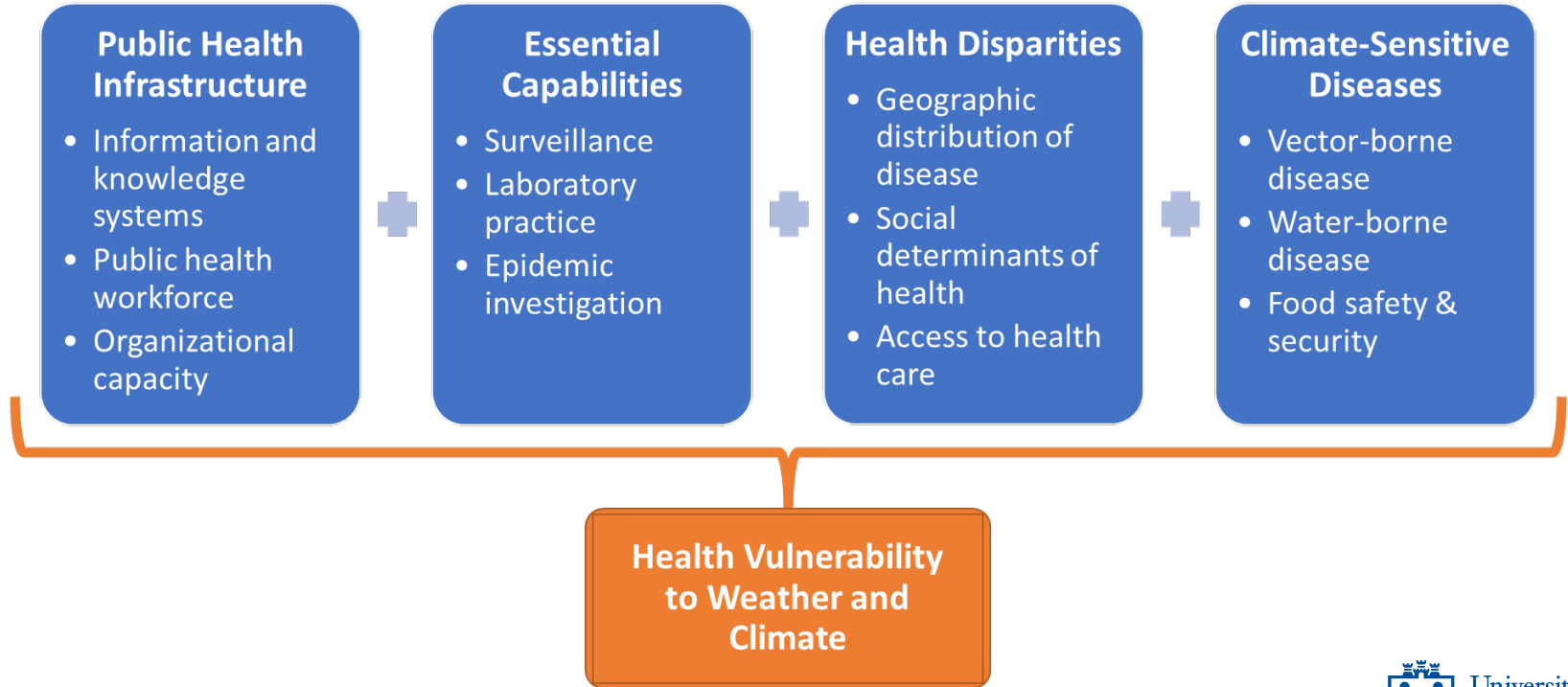
- Guides health professionals that manage health systems to identify and prepare for upcoming favorable or inclement climate conditions in the Caribbean in the very near future.
- Suggests several implications of forecasted climate for respiratory illness, non-communicable diseases, vector borne illness, gastrointestinal illness, physical injury or death, and well-being and mental health.
- Can help to inform strategic and operational decisions.



Environmental Scan Method

- Assesses contextual public health and weather and climate vulnerability in four domains
- Supports locally-informed planning and decision-making
- Collects information from internal and external sources (e.g., peer-reviewed literature, reports, policy documents) through literature reviews, surveys, interviews, and observations etc.
- Builds stakeholder engagement

Environmental Scan Domains



How Do We Promote Resilience in the Context of Climate Change?

Prevention – don't let it happen in the first place

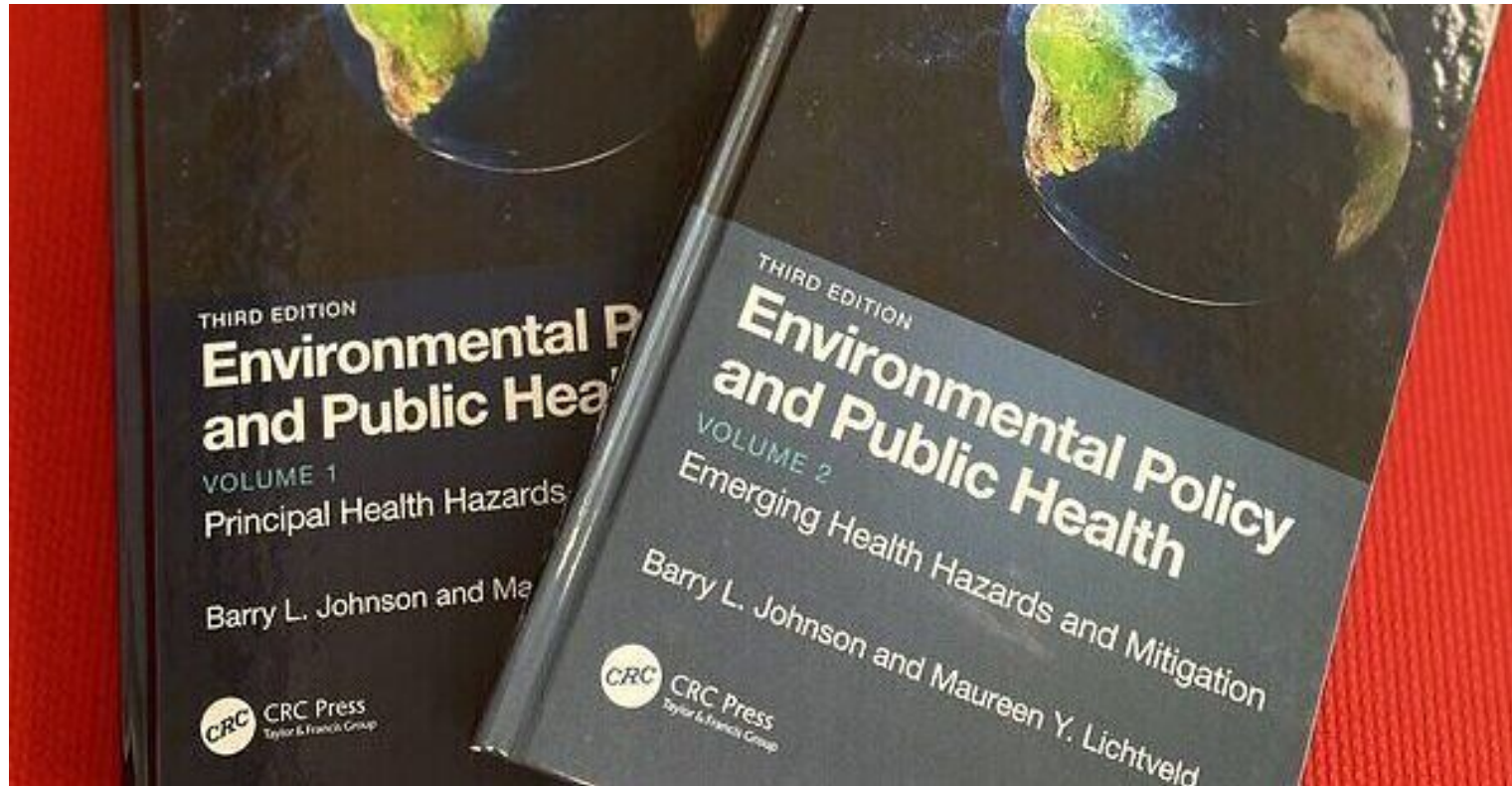
Prediction – use data to model or anticipate what will happen

Preparedness – use models to be ready

Resources

- Climate Services for Health: Improving public health decision-making in a new climate: <https://public.wmo.int/en/resources/library/climate-services-health-case-studies>
- Strengthening Climate Services for the Health Sector in the Caribbean: <https://public.wmo.int/en/resources/bulletin/strengthening-climate-services-health-sector-caribbean>
- Climate Change for Health Professionals: A Pocket Book: <https://iris.paho.org/handle/10665.2/52930>
- Caribbean Health Climatic Bulletin: <https://rcc.cimh.edu.bb/caribbean-health-climatic-bulletin/>
- IPCC Sixth Assessment Report, 2022: <https://www.ipcc.ch/report/ar6/wg2/>

A new textbook.....



CLIMATE CHANGES HEALTH

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