

The background of the slide is a photograph of an industrial facility, likely a power plant or refinery, with several tall smokestacks. Thick, dark plumes of smoke or steam are rising from the stacks, filling the sky and creating a hazy, yellowish-brown atmosphere. The sky is a pale, hazy blue, suggesting a clear day but with significant air pollution. The overall scene conveys a sense of industrial activity and its environmental impact.

Greenhouse Gases and the Global Burden of Disease

Digital Health for Climate Resilience

Lecture 1

Lecture Outline

Fundamentals: The Greenhouse Effect and Anthropogenic Drivers

The Framework: From Emissions to Health Outcomes

Quantifying the Crisis: The Global Burden of Disease (GBD) Approach

Pathway 1: Direct Health Impacts (Heat, Air Quality, Extreme Weather)

Pathway 2: Indirect Health Impacts (Infectious Disease, Nutrition, Mental Health)

Pathway 3: The "Threat Multiplier" Effect (Migration, Conflict)

Vulnerability and Climate Justice: Who Bears the Burden?

From Mitigation to Adaptation: The Role of Public Health

Conclusion and Key Takeaways

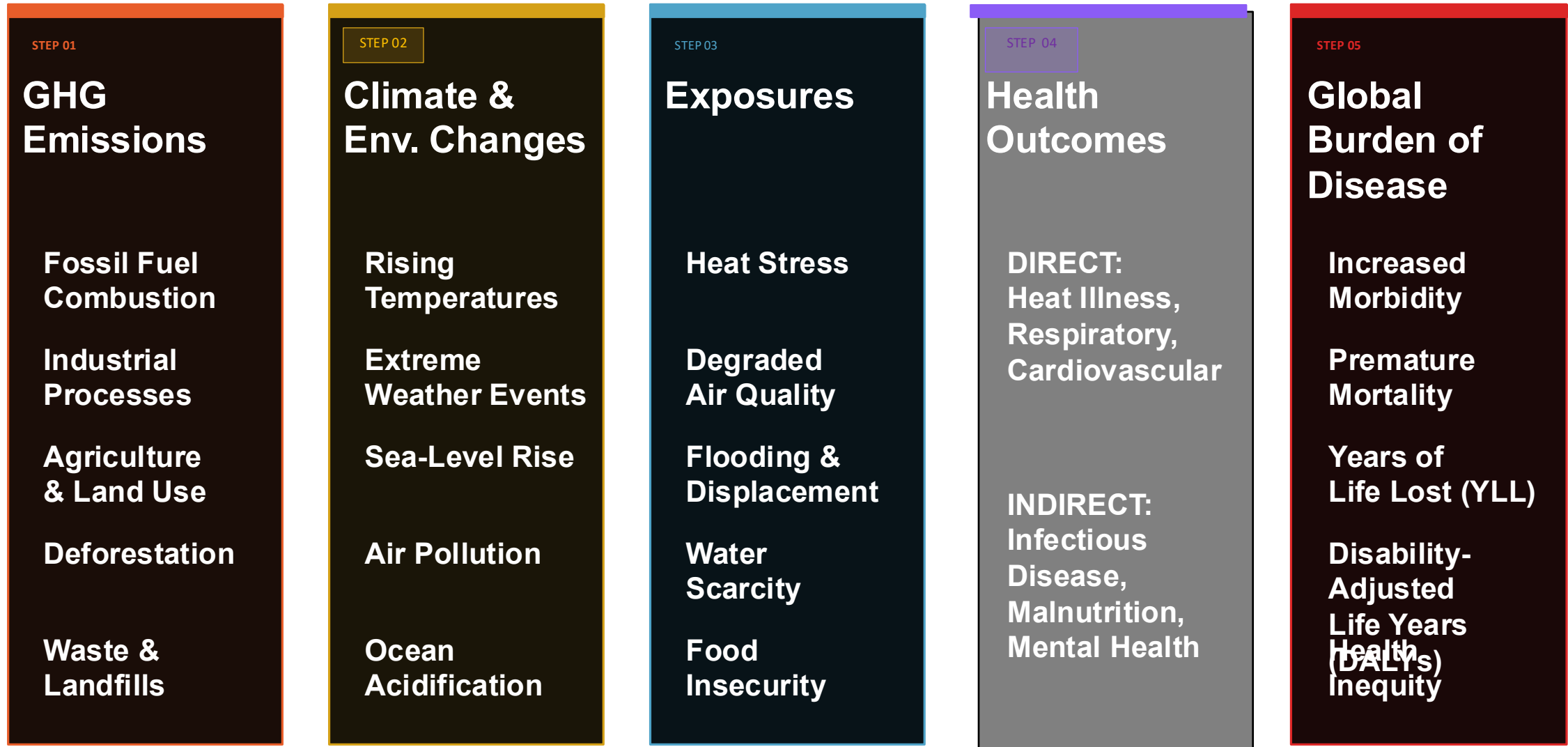
Fundamentals: The Greenhouse Effect

- **Natural Phenomenon:** Certain gases (GHGs) trap heat in the atmosphere, making Earth habitable
- **Key Greenhouse Gases (GHGs):**
 - Carbon Dioxide (CO₂) – from fossil fuel combustion and deforestation
 - Methane (CH₄) – from agriculture (livestock), landfills, and fossil fuel extraction
 - Nitrous Oxide (N₂O) – from agriculture (fertilizers) and industrial processes
 - Fluorinated Gases – from industrial applications (refrigerants, propellants)
- **Anthropogenic Intensification:** Human activities, primarily burning fossil fuels, have dramatically increased atmospheric GHG concentrations
 - CO₂ levels are now higher than at any point in at least 800,000 years



The Framework: From Emissions to Health Outcomes

A Causal Pathway Framework Linking Greenhouse Gas Emissions to Human Health Outcomes





Quantifying the Crisis: The Global Burden of Disease Approach

- **The "Attributable Burden" Challenge:** How many deaths and illnesses can be directly linked to climate change?
 - **WHO Projections (2030-2050):** An estimated **250,000 additional deaths per year** from:
 - Heat stress in the elderly
 - Malaria
 - Diarrheal disease
 - Childhood malnutrition
 - **Important Caveat:** This is likely a **gross underestimate**, as it captures only a subset of health outcomes (e.g., not including deaths from air pollution exacerbated by climate change, or from violent conflict)
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Pathway 1: Direct Health Impacts - Heat and Air Quality

- **Extreme Heat:**
 - Direct cause of heat stroke and heat exhaustion
 - Exacerbates chronic conditions, leading to increased mortality from cardiovascular and respiratory disease
- **Air Quality:**
 - Climate change increases ground-level ozone ("bad" ozone) formation
 - Wildfires, intensified by drought and heat, release massive amounts of particulate matter (PM_{2.5})
 - These pollutants are potent triggers for asthma, COPD, and cardiovascular events
- **Air pollution from fossil fuels is a major driver of both climate change and direct health harm.** In 2016, ambient and household air pollution were estimated to cause **7.1 million premature deaths globally**

Pathway 2: Indirect Health Impacts - Infectious Disease

- **Changing Geographic Range:** Warming temperatures allow disease vectors (like mosquitoes and ticks) to survive and reproduce at higher altitudes and latitudes
 - *Example:* Dengue fever, malaria, and Lyme disease are expanding into previously cooler regions
- **Extended Transmission Seasons:** Warmer temperatures and changing rainfall patterns lengthen the period when transmission is possible
- **Altered Life Cycles:** Temperature affects the replication rate of pathogens within vectors



Pathway 2: Indirect Health Impacts - Nutrition and Food Security

- **Reduced Crop Yields:** Increased temperatures and extreme weather (droughts, floods) directly reduce agricultural productivity
 - *Example:* A 1°C increase in growing season temperature can lead to a **2.5–16% loss in yields** of staple crops like maize, rice, and wheat
 - **Declining Nutrient Content:** Rising atmospheric CO₂ levels reduce the concentration of essential micronutrients (iron, zinc, protein) in staple crops like rice and wheat
 - **Consequences:** This leads to food insecurity, higher food prices, and increased rates of malnutrition and micronutrient deficiencies, particularly in low-income countries that rely heavily on these crops
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Pathway 2: Indirect Health Impacts - Mental Health

- **Acute Trauma:** Direct exposure to extreme weather events (hurricanes, floods, wildfires) leads to post-traumatic stress disorder (PTSD), anxiety, and depression
 - **Chronic Stress:** Long-term stressors such as displacement, loss of livelihood, and forced migration create persistent mental health burdens
 - **"Eco-Anxiety":** Chronic fear of environmental doom, particularly prevalent among younger populations, is an emerging concern
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Pathway 3: The "Threat Multiplier" Effect

- Climate change rarely acts in isolation. It exacerbates existing vulnerabilities and can trigger cascading crises
- **Population Displacement:** Sea-level rise, desertification, and extreme weather events can make areas uninhabitable, forcing mass migration
- **Conflict and Instability:** Resource scarcity (water, food) can exacerbate tensions and contribute to violent conflict
- **Health System Disruption:** Extreme events damage health infrastructure, disrupt supply chains for medicines, and interrupt essential health services (e.g., vaccination programs, chronic disease management)



Vulnerability and Climate Justice

- **Disproportionate Impact:** The health burden of climate change is not distributed equally
 - **The "Climate Justice" Principle:** Those who have contributed the least to the problem suffer the most from its consequences
 - **Populations at Highest Risk:**
 - Low-income communities and countries (LMICs)
 - Children, the elderly, and pregnant women
 - Indigenous populations
 - People with pre-existing medical conditions
 - Outdoor workers
 - **Within high-income countries,** the burden falls heaviest on marginalized communities (e.g., Black, Indigenous, and Latinx populations) due to systemic inequities in housing, healthcare access, and exposure
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From Mitigation to Adaptation: The Role of Public Health

- **Mitigation (Addressing the Cause):** Reducing GHG emissions
 - *Public Health Role:* Advocate for clean energy, sustainable transport, and healthy, low-carbon diets
 - *Co-Benefits:* Actions to mitigate climate change often have immediate health benefits (e.g., reduced air pollution from burning fewer fossil fuels)
- **Adaptation (Managing the Impacts):** Preparing for and responding to the health effects that are already unavoidable
 - *Public Health Role:* Strengthen disease surveillance , implement heatwave early warning systems, build climate-resilient health infrastructure, and engage communities in preparedness planning

Conclusion and Key Takeaways

- **Greenhouse gas emissions, primarily from fossil fuels, are the driver** of climate change, which is a fundamental threat to human health
- **The health impacts are vast and multifaceted**, ranging from direct injuries from heat and extreme weather to indirect effects on infectious disease, nutrition, and mental health
- **The WHO projects 250,000 additional deaths annually by 2030-2050** from a subset of climate-sensitive health outcomes—a likely underestimate
- **Climate change is a "threat multiplier,"** exacerbating existing vulnerabilities and undermining the social and environmental determinants of health
- **The burden is unjustly distributed**, with the least responsible communities suffering the most, making climate change a central issue of health equity and climate justice
- **Public health professionals have a critical role** in both **mitigation** (advocating for systemic change) and **adaptation** (building resilient systems and protecting populations)



Q&A / Discussion



Thank you.



Questions?



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