



# Climate-Sensitive Diseases and Extreme Weather Health Effects

Digital Health for Climate Resilience

Lecture 2



# Lecture Outline

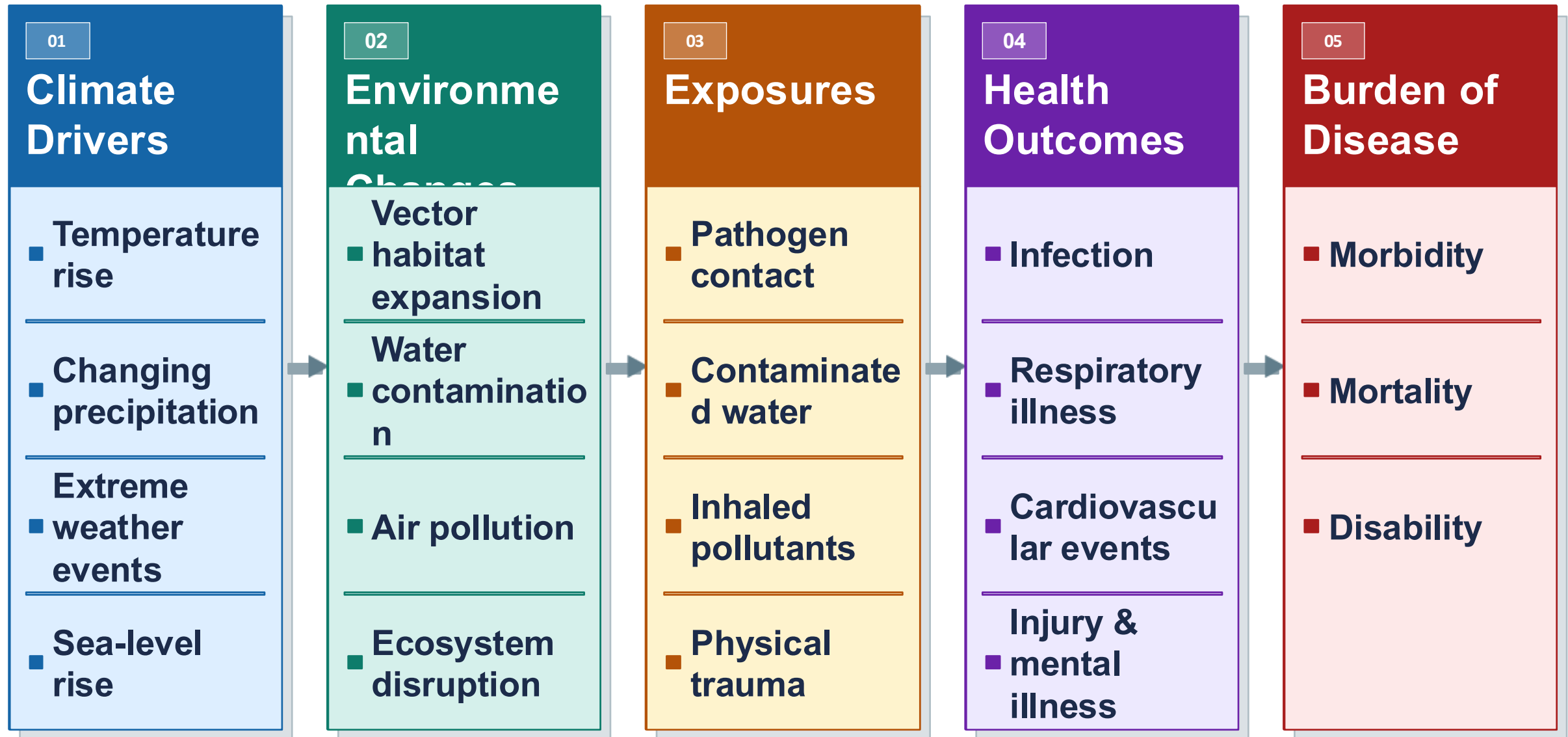
- **Defining Climate-Sensitive Diseases**
- **Conceptual Framework:** Climate Drivers → Environmental Changes → Health Outcomes
- **Extreme Weather Events:** Classification and Trends
- **Direct Health Effects of Extreme Weather**
- **Pathway 1:** Vector-Borne Diseases Under a Changing Climate
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- **Mental Health Impacts of Extreme Weather**
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# Defining Climate-Sensitive Diseases

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- **Broad Definition:** Diseases whose transmission dynamics, geographic distribution, and seasonal patterns are significantly influenced by climatic factors such as temperature, precipitation, and humidity
- **This extends beyond infectious diseases to include:**
  - **Non-communicable diseases:** Cardiovascular and respiratory conditions exacerbated by heat and air pollution
  - **Mental health disorders:** Trauma from extreme events, chronic stress from displacement
  - **Injuries and mortality:** Direct physical harm from extreme weather events
- **Key Insight:** Climate sensitivity is a property of the *disease system*, not just the pathogen

# Conceptual Framework: From Climate Drivers to Health Outcomes



# Extreme Weather Events: Classification and Trends

- **Types of Extreme Weather Events:**
  - **Heatwaves:** Prolonged periods of excessively hot weather
  - **Floods:** Riverine, coastal, and flash flooding from intense rainfall or storm surges
  - **Storms:** Hurricanes, cyclones, typhoons, and severe thunderstorms.
  - **Droughts:** Prolonged periods of below-average precipitation
  - **Wildfires:** Often triggered or intensified by drought and heat
- **Observed Trends:** Climate change is increasing the frequency, intensity, and duration of many of these events
  - *Example:* The number of heatwave days has increased significantly in most land regions since 1950.





# Direct Health Effects of Extreme Weather

- **Heatwaves:**
  - Direct cause of heat stroke and heat exhaustion
  - Exacerbation of cardiovascular, respiratory, and renal disease
  - *Quantitative evidence:* Extreme heat has a direct impact on cardiovascular disease mortality
- **Floods and Storms:**
  - Drowning and physical trauma
  - Injuries from debris and structural collapse
  - Electrocutation from downed power lines
- **Wildfires:**
  - Burns and smoke inhalation
  - Direct mortality from fire exposure
- **Droughts:**
  - Reduced water availability and quality
  - Crop failure leading to malnutrition

# Pathway 1: Vector-Borne Diseases

- **Key Vectors:** Mosquitoes (*Aedes*, *Anopheles*), ticks (*Ixodes*), sandflies
- **Climate Drivers:**
  - **Temperature:** Affects vector survival, reproduction, biting rate, and pathogen replication (extrinsic incubation period)
  - **Precipitation:** Provides breeding habitats; extremes can flush away or create breeding sites
  - **Humidity:** Influences vector longevity and activity
- **Observed Impacts:**
  - **Geographic Expansion:** Diseases like dengue, malaria, and Lyme disease are moving to higher altitudes and latitudes
  - **Extended Transmission Seasons:** Warmer temperatures lengthen the period when transmission is possible
  - **Quantitative Evidence:** A 1°C rise in temperature is associated with an **8–10% increase in dengue incidence**



# Pathway 2: Water-Borne and Food-Borne Diseases

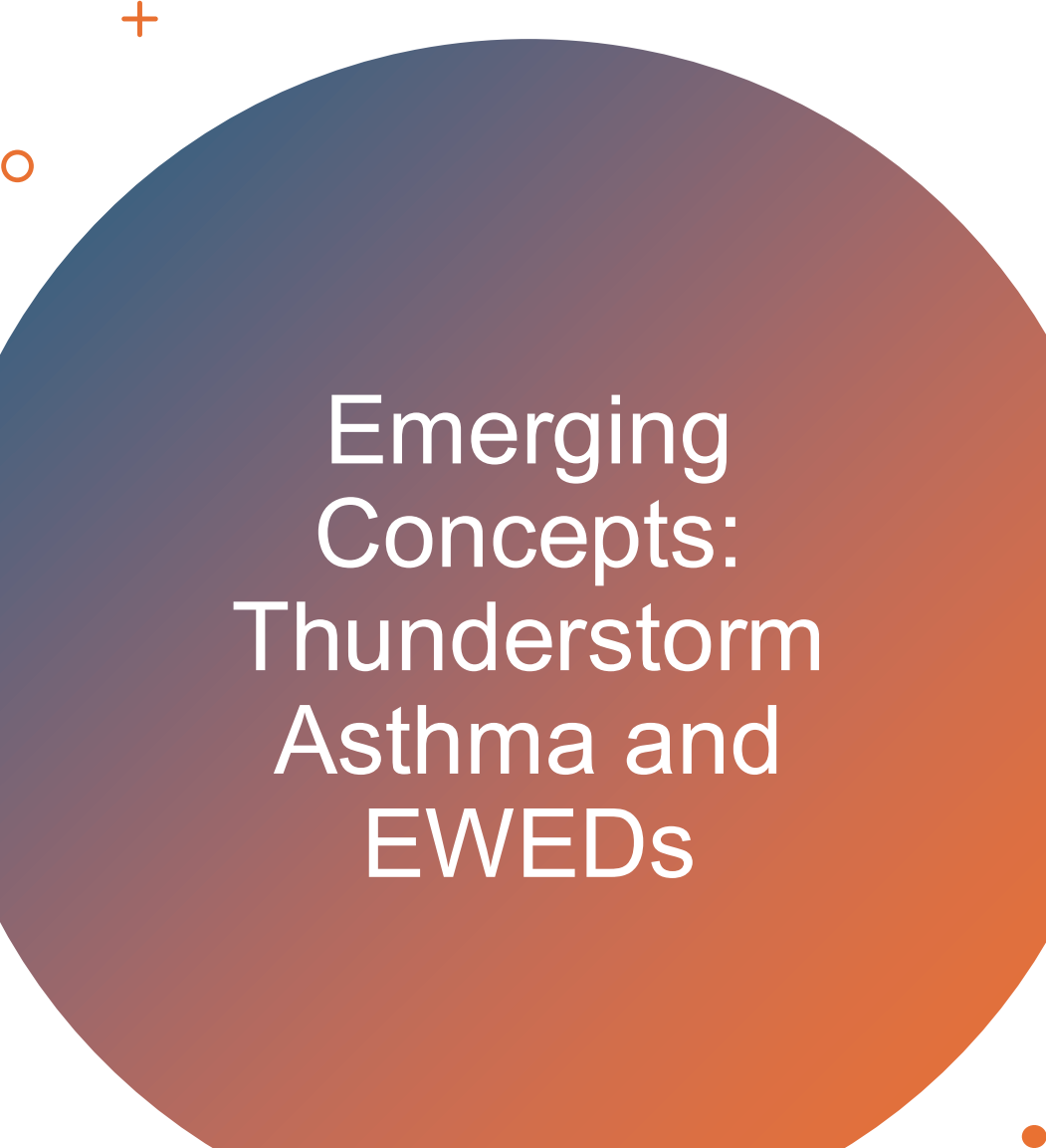
- **Mechanisms:**
  - **Heavy Rainfall and Flooding:** Can overwhelm sewage systems and cause runoff of animal waste, contaminating drinking water sources with pathogens like *Vibrio cholerae*, *Cryptosporidium*, and norovirus
  - **Rising Temperatures:** Promote the growth of pathogens in water (e.g., *Vibrio* species in coastal waters)
  - **Drought:** Reduces water availability for hygiene, increasing the risk of diarrheal diseases like trachoma and scabies
- **Food-Borne Pathogens:** Salmonella and Campylobacter replicate faster in warmer temperatures, increasing the risk of foodborne outbreaks



# Pathway 3: Respiratory Diseases and Air Quality

- **Mechanisms:**
  - **Wildfire Smoke:** Contains high levels of PM2.5, CO, and other pollutants, causing respiratory and cardiovascular harm
  - **Ground-Level Ozone:** Higher temperatures accelerate the chemical reactions that form tropospheric ozone, a potent respiratory irritant
  - **Thunderstorm Asthma:** A unique phenomenon where storms rupture pollen grains, releasing allergenic sub-particles that can trigger severe asthma attacks
- **Quantitative Evidence:** Extreme weather events contribute to a **30% rise in respiratory diseases**





# Emerging Concepts: Thunderstorm Asthma and EWEDs

- **Thunderstorm Asthma:**
  - Mechanism: Large pollen particles rupture due to moisture, releasing sub-particles small enough to penetrate deep airways
  - Risk: Affects individuals with and without known asthma
  - Public Health Challenge: Requires integrated surveillance of pollen, weather, and health data
- **Extreme Weather-Epidemic Compound Disasters (EWEDs):**
  - Definition: Complex disaster systems where extreme weather events interact with infectious disease outbreaks, creating amplified health risks through non-linear effects
  - Example: A flood (extreme weather) contaminating water sources during a cholera outbreak (epidemic), while simultaneously destroying health infrastructure and displacing populations
  - Implication: Health systems must prepare for compound, cascading crises, not single events

# Mental Health Impacts of Extreme Weather

- **Acute Effects:**
  - Post-Traumatic Stress Disorder (PTSD) following direct exposure to life-threatening events (hurricanes, floods, wildfires)
  - Acute stress reactions, anxiety, and grief (loss of loved ones, homes, possessions)
- **Chronic Effects:**
  - Depression and anxiety related to displacement, livelihood loss, and ongoing uncertainty
  - "Solastalgia": The distress caused by environmental change impacting people while they remain in their home environment
- **Population-Level Impact:** Exposure to climate-related disasters significantly increases risks of PTSD, anxiety, and depression



# Vulnerability and Differential Impacts

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- **The burden is not evenly distributed.** Vulnerability is a function of exposure, sensitivity, and adaptive capacity
- **Populations at Highest Risk:**
  - **Low-income communities:** Often reside in flood-prone areas, have poorer quality housing, and lack resources for adaptation (air conditioning, insurance) .
  - **Older adults:** Reduced physiological capacity to thermoregulate; higher prevalence of chronic diseases
  - **Children:** Greater susceptibility to dehydration, certain pollutants, and psychological trauma
  - **Pregnant women:** Increased risk of adverse birth outcomes following heat exposure and stress
  - **Outdoor workers:** Face unavoidable exposure to heat, smoke, and extreme weather
  - **Indigenous populations:** Often reliant on climate-sensitive resources for livelihoods and cultural practices
  - **Racial and ethnic minorities:** Face systemic inequities in housing, healthcare access, and political representation that compound climate vulnerability

# Health System Implications and Adaptation

- **Increased Burden:** More patients during and after extreme events (trauma, respiratory, mental health)
- **Infrastructure Disruption:** Health facilities may be damaged or destroyed; power and water supplies may fail
- **Supply Chain Interruption:** Medicines, vaccines, and equipment may not reach those who need them
- **Workforce Challenges:** Health workers may be unable to reach facilities or may be personally affected
- **Adaptation Strategies:**
  - **Early Warning Systems:** Heat-health action plans, flood forecasting linked to health data
  - **Climate-Resilient Infrastructure:** Building or retrofitting health facilities to withstand extreme events
  - **Surveillance Strengthening:** Integrated climate-health surveillance for early outbreak detection
  - **Workforce Training:** Equipping health workers to recognize and manage climate-sensitive diseases
  - **Community Engagement:** Co-designing preparedness plans with vulnerable communities



# Conclusion and Key Takeaways



**Climate-sensitive diseases encompass a wide range of conditions**, from vector-borne infections to cardiovascular stress and mental illness



**Extreme weather events are increasing in frequency and intensity**, causing direct injuries and mortality, and triggering cascading health impacts



**Climate change alters disease transmission dynamics**—expanding geographic ranges, lengthening seasons, and intensifying outbreaks



**Emerging concepts like EWEDs highlight the need to prepare for compound, cascading crises**, not just single events



**The health burden is unequally distributed**, falling most heavily on vulnerable populations and exacerbating existing health inequities



**Building climate-resilient health systems** through early warning, resilient infrastructure, surveillance, workforce training, and community engagement is essential for protecting populations

# Q&A / Discussion



**Thank you.**



**Questions?**

# References

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