From higher gases to human impacts

Increases in greenhouse gas concentrations alter the climate. This topic connects the physical change to rising seas, shifting disease risks and changes in where populations live.

1. TRACE THE CAUSE-AND-EFFECT CHAIN

MORE GASES

Human emissions raise atmospheric greenhouse gas concentrations.

→

MORE WARMING

Stronger infrared absorption alters the energy balance.

→

CHANGING RISKS

Sea levels and climatic conditions change, affecting people and ecosystems.

The natural greenhouse effect supports life; the concern is its human-driven intensification. Higher greenhouse gas concentrations initially reduce heat escaping to space at a given temperature, so the Earth system gains energy.

2. SOURCE CONTEXT: WHY CONCENTRATIONS RISE

Burning coal, oil and gas transfers stored carbon into atmospheric CO_2. Deforestation can release carbon and reduce future uptake. Livestock, landfills and fossil-fuel leaks add CH_4; nitrogen fertilizer use can increase N_2O emissions. These activities connect local choices to global impacts.

3. TWO CORE PATHWAYS TO KNOW

Coasts: ocean warming and land-ice loss → higher sea level → flooding, habitat loss and pressure to relocate.

Health: altered temperature and rainfall → changed vector habitat or active season → changed disease exposure and population health.

Population dynamics include changes in population size and distribution. Movement, altered survival and changing resource availability can all contribute; a climate impact does not produce the same response everywhere.

Greenhouse mechanism and human sources: NASA, Causes of Climate Change.
Required impact pathways: College Board APES CED, Topic 9.4.

Scope: College Board APES CED, Topic 9.4, STB-4.E and STB-4.E.1, p. 185.

Why sea level rises

Two major mechanisms connect warming to global mean sea-level rise: seawater occupies more volume as it warms, and melting land-based ice adds water to the ocean.

1. TWO MECHANISMS, ONE RISING OCEAN

A. THERMAL EXPANSION

Warming seawater expands.

The same mass occupies more volume. Additional water is not required for this contribution to sea-level rise.

B. LAND-ICE LOSS

Glaciers and ice sheets lose ice.

When this water reaches the ocean, ocean mass increases. Greenland and Antarctica contain major land-based ice stores.

2. DO NOT CONFUSE LAND ICE WITH FLOATING SEA ICE

Floating sea ice already displaces seawater, so its melting has little direct effect on sea level. Its loss still matters: less reflective ice means more solar energy is absorbed by the darker ocean, reinforcing warming. Land-ice loss and thermal expansion are the main direct mechanisms.

3. FOLLOW THE CONSEQUENCES INLAND

A higher starting sea level allows high tides and storm surges to reach farther inland. Flooding and erosion can damage homes, roads and coastal habitats. Saltwater intrusion can affect freshwater supplies and farmland. Repeated losses can reduce livelihoods and increase pressure to move.

Local sea-level change can differ from the global average because land rises or sinks and ocean conditions vary. An identical global rise therefore does not imply identical local flooding or displacement.

Sea-level mechanisms and coastal impacts: NOAA, Is Sea Level Rising?
Floating ice and the ice-albedo feedback: NOAA, Sea Ice and Global Climate.
Population movement and vulnerability: IPCC AR6 WGII, Technical Summary.

Scope: College Board APES CED, Topic 9.4, STB-4.E and STB-4.E.1, p. 185.

Disease ranges and population change

A vector carries a pathogen between hosts. Climate change can shift where vectors survive and how long they remain active, changing the places and seasons in which transmission is possible.

1. WARMING CAN OPEN NEW VECTOR HABITAT

CLIMATE SHIFTS

Warmer conditions or altered rainfall change habitat suitability.

→

VECTORS RESPOND

Some mosquitoes or ticks expand poleward, uphill or into longer active seasons.

→

EXPOSURE CHANGES

People in newly suitable areas may encounter vectors carrying pathogens.

Examples: mosquito-borne malaria and dengue; tick-borne Lyme disease. A vector carries the pathogen, which is the disease-causing organism.

2. SUITABLE CLIMATE DOES NOT GUARANTEE AN OUTBREAK

Transmission also requires the pathogen, susceptible hosts and contact. Housing, vector control and healthcare affect risk. Rainfall, humidity and temperature interact: excessive heat or unsuitable moisture can reduce survival. Not every vector expands, and not every warming location has more disease.

3. POPULATION RESPONSES ARE NOT ALL THE SAME

Flood damage, lost livelihoods and health risks may change survival, settlement patterns and migration. Some people relocate; others adapt in place or lack the resources to leave. Movement may be temporary or lasting. Climate interacts with economic and social conditions rather than determining every migration decision.

Supporting responses: disease surveillance and vector control reduce exposure; coastal planning reduces flood risk. These are adaptation measures. Cutting greenhouse gas emissions addresses the warming driver and is mitigation.

Vectors, pathogens and health risk: IPCC AR6 WGII, Chapters 7 and 16.
Range shifts into previously colder areas: IPCC AR6 WGII, Chapter 16.
Migration, vulnerability and adaptation: IPCC AR6 WGII, Technical Summary.

Scope: College Board APES CED, Topic 9.4, STB-4.E and STB-4.E.1, p. 185.