Climate and resources

IB DP Geography core units 2 and 3: climate vulnerability and resilience; resource consumption and security

201.9 mm in one hour

> Warmer air holds more water, so very heavy rain is more common.

- Zhengzhou, July 2021: the highest hourly total ever in mainland China.
- One storm cannot prove climate change; the trend can.

The energy balance

> Of 100 units of sunlight: 30 reflected, 20 warm the air, 50 warm the ground.

- If energy in equals energy out, the temperature stays the same.
- Clouds, ice and the air reflect about 30%.

The greenhouse effect

> Without it the Earth would average about −18 °C, not 15 °C.

- Greenhouse gases: carbon dioxide, methane, water vapour.
- They absorb heat from the ground and send part back down.

The enhanced greenhouse effect

People add greenhouse gases and make the effect stronger.

- Cattle and rice fields release methane.
- More gas traps more heat.

The Keeling curve

> CO_2 rose from 317 ppm in 1960 to 425 ppm in 2024.

- Measured at Mauna Loa, Hawaii, since 1958.
- Ice cores: 180 to 300 ppm for 800,000 years before industry.

Percentage increase

1. **Since 1960** $(425 - 317) \div 317 \times 100 \approx 34\%$
2. **Since pre-industrial** $(425 - 280) \div 280 \times 100 \approx 52\%$

Decision

The same data gives 34% or 52%: the baseline matters.

Warmer and higher

About 1.1 °C warmer, and seas about 20 cm higher.

- Water expands as it warms.
- Glaciers and ice sheets melt.

Natural causes

None of these explains the fast warming since 1950.

- Orbit changes act over tens of thousands of years.
- A large eruption cools the Earth for a year or two.

Positive feedback

> Warming melts ice; dark ground absorbs more sunlight; warming grows.

- Thawing **permafrost** releases methane: more warming.
- Past a **tipping point**, change is hard to reverse.

Consequences

The Earth system

Hotter heatwaves, heavier rain, longer droughts.

Warmer, more acidic oceans; rising seas.

People

Health: heat stress, dengue spreading.

Food: lower yields in hot regions.

Migration from flooded or dry land.

Vulnerability

Factor	Meaning	Example
exposure	how much hazard arrives	Tuvalu: mostly under 3 m
sensitivity	how much damage it does	rain-fed farmers
capacity	means to respond	Dutch sea defences

Resilience in Bangladesh

1970: hundreds of thousands died. 2020: a few dozen.

- Cyclone shelters, trained volunteers, warnings by radio and phone.
- The hazard was similar; the capacity was very different.

Mitigation and adaptation

Mitigation acts on the cause; **adaptation** reduces the damage.

- Mitigation: solar, wind, electric vehicles, forests, carbon capture.
- Adaptation: sea walls, sponge cities, early warnings.

Responses at every scale

Scale	Example	Judgement
global	**Paris Agreement**, 2015	pledges voluntary, too small
national	China: peak by 2030, **carbon trading**	big: a third of world CO_2
city	sponge cities, such as Wuhan	Zhengzhou rain beyond design
civil society	Fridays for Future, 2018	attention, unclear effect

Evaluate in four moves

1. **Name and scale** The **Paris Agreement**: global.
2. **How it works** Countries pledge cuts and review them every five years.
3. **A number** Target: well below 2 °C.
4. **A limit** Pledges are voluntary; warming still expected past 2 °C.

Decision

Strategy, mechanism, number, limit: a balanced judgement.

Geoengineering

Might

Cool the Earth quickly.

But

Oceans still turn more acidic from CO_2.

Rainfall could change in other countries.

The ecological footprint

> We use about 2.6 gha each, but the Earth supplies about 1.6.

- 8 billion people in 2022; a growing **middle class** buys more.
- Earth Overshoot Day 2024: 1 August.

Renewable and non-renewable

Renewable

Fish, forests, wind, sunlight.

Lasts if used no faster than it renews.

Non-renewable

Coal, oil, metals.

A fixed amount.

Water security

Physical scarcity

Too little water.

The Middle East.

Economic scarcity

Water exists, but people cannot pay for pipes and pumps.

Parts of sub-Saharan Africa.

Four pillars of food security

Availability, access, utilisation, stability.

- A famine can happen even when a country has enough food.
- If the poor cannot afford it, access fails.

Energy security

> China imports about 70% of its crude oil, so it invests in home-grown energy.

- A reliable supply at an affordable price.
- Much of China's oil arrives by sea.

The water–food–energy nexus

> Maize for biofuel saves oil but uses farmland and water.

- The three resources depend on each other.
- Using more of one changes the others.

Malthus: food falls behind

> Population grows faster than food, until crisis.

- Thomas Malthus, 1798.
- Famine, disease and war would stop growth.

Boserup: invention keeps up

So far Boserup is closer, but the limit may come from the environment.

- Ester Boserup, 1965: "necessity is the mother of invention".
- The **Green Revolution**: new seeds, fertiliser, irrigation.

Stewardship

> Keep materials in use instead of take, make, throw away.

- UN SDGs (2015): Goal 6 water, Goal 7 energy, Goal 12 consumption.
- China's **Circular Economy** Promotion Law, 2008.

Check yourself

Energy balance and the **enhanced greenhouse effect**

CO_2 280 $\rightarrow$ 317 $\rightarrow$ 425 ppm; 34% and 52%

Feedbacks; **vulnerability**; Bangladesh 1970 and 2020

Mitigation and adaptation at four scales

Footprint 2.6 vs 1.6; water, food, energy; Malthus, Boserup