**COURSE N 07**

**ENVIRONMENTAL PROBLEMS**

**4) Greenhouse Gases (GHGs)**

**1) Definition**

**Greenhouse Gases (GHGs)**

Are gases in Earth's atmosphere that trap heat by absorbing and emitting **infr**ared radiation, contributing to the **greenhouse** effect.

This natural process helps maintain Earth's temperature, making it suitable for life. **However**, **excessive concentrations of these gases,** primarily due to human activities, increase the greenhouse effect, leading to **global warming** and **climate change.**

**Major GHGs:**

1. **Carbon dioxide (CO₂):** Released from burning fossil fuels and industrial processes.
2. **Methane (CH₄):** decomposition of organic waste, agriculture
3. **Nitrous oxide (N₂O):** Generated by agricultural practices, such as **fertilizer** application, and certain industrial activities.
4. **Fluorinated gases (e.g., HFCs, PFCs, SF₆):** Synthetic gases used in industrial applications, refrigeration, and air conditioning.

**2) Natural vs. Anthropogenic GHGs:**

* **Natural GHGs** occur naturally, such as water vapor, which is the most abundant GHG.
* **Anthropogenic GHGs** are produced by human activities, significantly increasing their atmospheric levels and intensifying their impact on the climate.

These gases **vary** in their **Global Warming Potential (GWP)** and atmospheric lifetimes, influencing their overall impact on Earth's climate system

3) **Sources of Greenhouse Gases**

* **Natural sources:**
	+ Volcanic eruptions.
	+ Respiration and natural decomposition.
* **Anthropogenic sources:**
	+ Burning of fossil fuels (**transportation**, **industry**).
	+ Agriculture (livestock, rice paddies or fields).
	+ Industrial processes (e.g., cement production)

**4) Impacts of Greenhouse Gases (GHGs)**

Greenhouse gases (GHGs) play a significant role in **altering** the **Earth's** **climate** and environment.

**As** GHGs, **particularly** carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), **accumulate** in the **atmosphere**, they **trap** **heat** and lead to various **harmful** environmental, social, and economic effects.

**1. Climate Change and Global Warming**

* **Global Warming** (Réchauffement climatique) (الاحترار العالمي) is the **rise** in Earth’s average temperature **due** to the increased greenhouse effect.
* This warming disrupts **weather patterns**, leading to more extreme weather events like **heatwaves**, **storms**, and **floods**.
* **Climate Change** refers to long-term **shifts** in temperature and weather patterns. Human activities, such as the burning of fossil fuels and deforestation, have drastically increased the concentration of GHGs, **especially CO₂.**
	+ **Consequences**:
		- Changes in precipitation patterns.
		- Increased frequency of extreme weather events (e.g., heatwaves, heavy rainfall).
		- Disruption of ecosystems and agricultural systems.

**2. Sea-Level Rise and Melting Ice Caps**

* As global temperatures rise, the polar ice caps (particularly in Greenland and Antarctica) are melting at an accelerated rate.
* **Thermal Expansion**: Warmer oceans expand, contributing to rising sea levels.
	+ **Consequences**:
		- **Coastal flooding**: Inundation of low-lying coastal areas, displacing millions of people.
		- **Erosion of shorelines**: Loss of land and ecosystems such as wetlands.
		- **Damage to infrastructure**: Coastal cities and infrastructure (ports, roads) face significant damage or displacement.
		- **Threat to freshwater resources**: Melting glaciers are an essential freshwater source for many regions, and their loss threatens water supply.

**3. Ocean Acidification**

* **Process**: Increased CO₂ in the atmosphere also leads to higher concentrations of CO₂ in the oceans. When CO₂ dissolves in seawater, it reacts with water to form carbonic acid, lowering the ocean’s pH.
* **Consequences**:
	+ **Disruption of marine life**: Acidification harms marine species, particularly those that **rely** on calcium carbonate for their shells and skeletons, such as corals, shellfish, and plankton.
	+ **Impact on food chains**: Since these species are vital to marine food webs, their decline affects entire ecosystems and the livelihoods of people dependent on fishing industries.
	+ **Coral Bleaching**: تبييض الشعاب المرجانية Warmer waters, in combination with ocean acidification, lead to coral bleaching, which weakens coral reefs.

**4. Biodiversity Loss**

* **Habitat Disruption**: Climate change alters habitats, making them unsuitable for many species.
* **Species** Extinction: Many species cannot adapt quickly enough to the changing climate, leading to extinction or a decline in biodiversity.
	+ **Consequences**:
		- **Loss of Ecosystem Services**: Biodiversity is crucial for services like pollination, water purification, and pest control. The loss of species can destabilize ecosystems.
		- **Food Security**: Many plants and animals are vital for agriculture and food production. Loss of biodiversity threatens global food security and agriculture productivity.
		- **Ecosystem Imbalance**: The loss of certain species can result in imbalanced ecosystems, disrupting predator-prey relationships and the natural cycles of ecosystems.

**5. Health Effects (Heatwaves, Air Quality)**

* **Heatwaves**: The increasing frequency and intensity of heatwaves due to global warming have severe health impacts, especially on vulnerable populations.
	+ **Consequences**:
		- **Heat-related illnesses**: Increased mortality from heat stress, dehydration, and cardiovascular issues.
		- **Vector-borne diseases**: الأمراض المنقولة بواسطة الحشرات Warmer temperatures and shifting weather patterns can expand the range of disease vectors (e.g., mosquitoes), leading to the spread of diseases like malaria, dengue, and Zika virus.
		- **Increased air pollution**: Higher temperatures can lead to more smog and pollutants in the air, worsening respiratory conditions like asthma and increasing the prevalence of heart disease.
		- **Mental health**: Heatwaves and other climate impacts can cause stress and anxiety, especially in vulnerable communities.

**6. Economic Implications (Disasters, Agriculture)**

* **Natural Disasters**: The increase in extreme weather events (floods, hurricanes, wildfires) due to climate change results in massive economic losses.
	+ **Consequences**:
		- **Damage to infrastructure**: Rebuilding after storms, floods, and fires is costly for governments and businesses.
		- **Agricultural Disruption**: Changes in temperature, rainfall patterns, and extreme weather events can reduce agricultural productivity, especially for crops that are sensitive to climate variations.
		- **Loss of livelihoods**: Smallholder farmers and workers in agriculture or tourism industries are at risk of losing their livelihoods due to changing weather patterns or disaster events.
		- **Health** Care **Costs**: Increased health care costs related to climate-induced diseases (heatstroke, respiratory diseases, etc.) and recovery from climate-related disasters.
		- **Insurance and Recovery**: Insurance companies face higher costs due to the rising frequency and severity of disasters, leading to increased premiums and financial instability for individuals and businesses.

**5) Strategies to Mitigate Greenhouse Gases**

* Transition to renewable energy (solar, wind, hydropower).
* Energy efficiency and conservation:

**Energy efficiency** refers to using less energy to perform the same task or achieve the same outcome. It involves improving systems, technologies, and processes so that less energy is wasted in the process of producing goods or providing services.

* Carbon capture and storage (CCS):

**Carbon Capture and Storage (CCS)** is a set of technologies aimed at capturing carbon dioxide (CO₂) emissions produced from the use of fossil fuels or industrial processes and storing it underground to prevent it from entering the atmosphere. This process helps mitigate climate change by reducing the amount of CO₂, a major greenhouse gas, in the air.

* Afforestation (converting (land) into forest,) and **reforestation** (the process of replanting an area with **trees**)
* Sustainable agriculture and waste management.
* Policies and agreements (e.g., Paris Agreement).

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1. **Fill in the Gaps**

 **fossil fuels - Ocean acidification - Global warming - energy efficiency - Carbon dioxide -Infrared- Fluorinated gases-** **volcanic eruptions- melting**

1. Greenhouse gases (GHGs) trap heat in the Earth’s atmosphere by absorbing and emitting **Infrared** radiation.
2. **Carbon dioxide**  (CO₂) is primarily released from burning fossil fuels and industrial processes.
3. The process of **energy efficiency**  refers to using less energy to perform the same task or achieve the same outcome.
4. **Fluorinated gases** is a synthetic gas used in refrigeration and air conditioning, contributing to the greenhouse effect.
5. \_**Global warming**  is the increase in Earth’s average temperature due to the enhanced greenhouse effect caused by **human activities**.
6. One of the primary natural sources of greenhouse gases is volcanic eruptions, which can release CO₂ into the atmosphere.
7. \_\_\_\_\_\_\_\_\_\_ is the process by which CO₂ dissolves in seawater, leading to a drop in the ocean's **pH**.
8. The rise in global temperatures due to climate change is contributing to the \_**melting** of polar ice caps and glaciers.
9. The burning of **fossil fuels**  (e.g., coal, oil, natural gas) in transportation and industry is a significant anthropogenic source of greenhouse gases.

**2. Matching**

**Match the greenhouse gas to its primary source:**

Greenhouse Gas (GHG) Source

A) Carbon dioxide (CO₂) 1) Decomposition of organic waste (e.g., livestock)

B) Methane (CH₄) 2) Burning fossil fuels in power plants or transportation

C) Nitrous oxide (N₂O) 3) Fertilizer use in agriculture

D) Fluorinated gases 4) Industrial processes like refrigeration

**3. True or False**

1. **Global Warming** refers to the long-term changes in temperature and weather patterns, including shifts in precipitation.
	* True
	* **False**
2. **Carbon Capture and Storage (CCS)** can only be used to mitigate emissions from transportation, not from industries.
	* True
	* **False**
3. **Ocean Acidification** occurs when CO₂ in the atmosphere dissolves into the oceans, leading to a decrease in the ocean's pH.
	* **True**
	* False
4. **Afforestation** is the process of **converting** non-forested land into forested land, helping to mitigate greenhouse gas emissions.
	* **True**
	* False
5. **Heatwaves** due to global warming can contribute to increased mortality from dehydration and cardiovascular diseases.
	* **True**
	* False

**4. Multiple Choice Questions**

1. Which of the following is **not** a natural source of greenhouse gases?
	* A) Volcanic eruptions
	* B) Decomposition of organic waste
	* **C) Industrial processes**
	* D) Respiration by animals
2. Which greenhouse gas is most commonly associated with agricultural practices?
	* A) Carbon dioxide (CO₂)
	* B) Methane (CH₄)
	* **C) Nitrous oxide (N₂O)**
	* D) Fluorinated gases
3. What is the main consequence of **sea-level rise** due to global warming?
	* **A) Coastal flooding and displacement of populations**
	* B) Increased agricultural productivity
	* C) Improved marine biodiversity
	* D) Reduced energy consumption
4. **Which of the following is not a strategy to mitigate greenhouse gas emissions?**
	* **A) Transition to renewable energy**
	* **B) Carbon capture and storage (CCS)**
	* **C) Increased use of fossil fuels**
	* **D) Reforestation and afforestation**
5. **What is the primary purpose of carbon capture and storage (CCS) technology?**
	* **A) To recycle carbon emissions for industrial use**
	* **B) To prevent CO₂ emissions from entering the atmosphere by storing it underground**
	* **C) To increase the production of fossil fuels**
	* **D) To cool down the Earth’s atmosphere**