

## Subject: Geography

### Topic: Variable Weather and Changing Climate

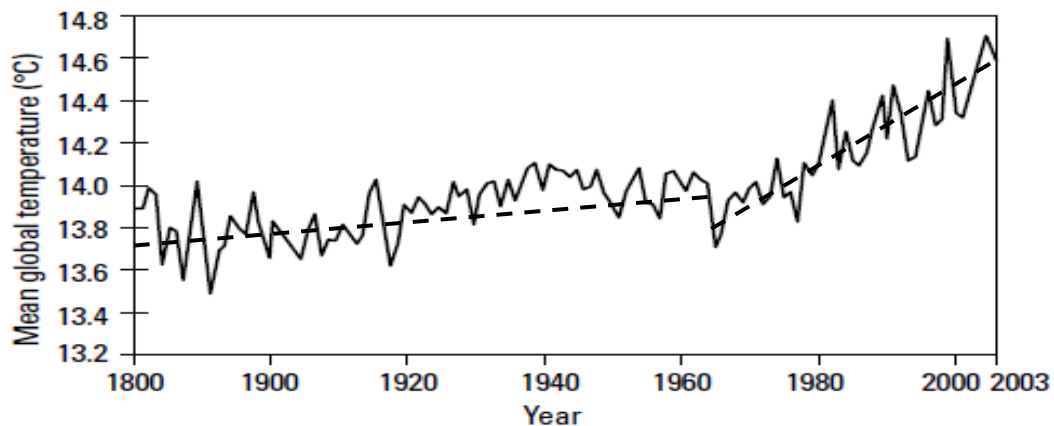
#### Gateway 2: What is happening to the Earth's climate?

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- A. How has global climate changed?
- B. What are some natural causes of climate change?
- C. What is the greenhouse effect?
- D. How do human activities lead to enhanced greenhouse effect?
- E. How does climate change affect people?
- F. What are the responses to climate change?

#### A. How has global climate changed?

- Global Climate Change: variation in the global climate or climatic patterns in the long term.



- Changes in global climate since 1881.
  - Earth warmed up by 0.74°C in 100 years.
  - Greatest increase after 1980s
  - Some places recorded much higher temperature increases.
  - For example: Arctic, Asia and Africa (1.2° C to 1.4 ° C)

#### B. What are some natural causes of climate change?

1. Variations in solar output
2. Volcanic eruptions

##### 1. Variations in solar output

- The magnetic activity of the sun has a cycle that lasts about 11 years.
- An increase in solar radiation is due to an increase in sun spots.
  - Areas surrounding the sunspots radiate more energy to make up for the cooler sunspot areas.
- With higher solar radiation, earth's temperatures will increase.



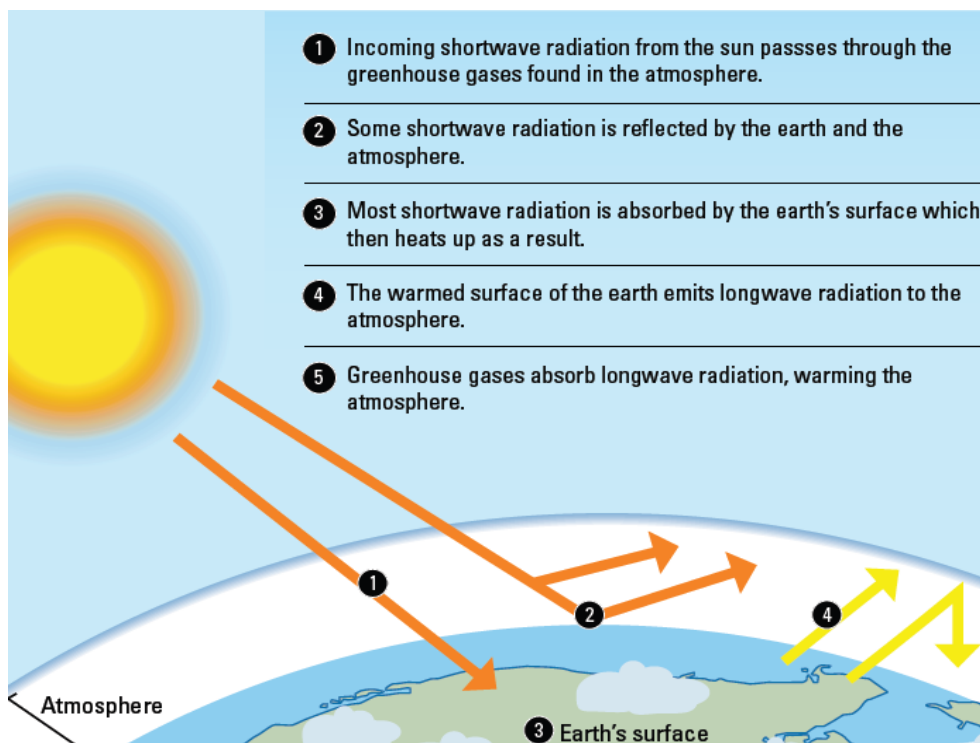
Sunspots represented by the dark spots on surface of the sun.

## 2. Volcanic eruptions

- Global dimming: Gradual reduction in the amount of sunlight reaching the earth's surface. Temporarily cools the earth for months or years.
  - Dust particles from eruption form condensation nuclei, creating more cloud cover.
  - Dust and ash also reflect away incoming solar radiation.
- For example, Mount Pinatubo eruption lowered temperatures by as much as  $0.6^{\circ}\text{C}$  for as long as two years.

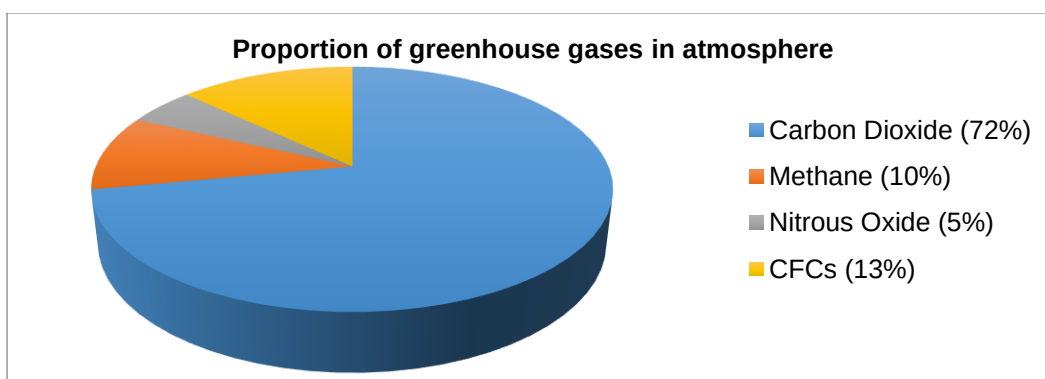
## C. What is the greenhouse effect?

- Greenhouse effect: Natural process in which the gases in the Earth's atmosphere trap longwave radiation emitted from the Earth's surface, warming the atmosphere.
- Water vapour, carbon dioxide, methane, nitrous oxide ozone and halocarbons such as chlorofluorocarbons (CFCs) are good absorbers of longwave radiation.
  - They are known as greenhouse gases and are found in the atmosphere.



- Enhanced greenhouse effect: Increase in the concentration of greenhouse gases in the atmosphere, leading to a rise in global temperatures.
  - Generally due to human activities that release an increased amount of greenhouse gases, most notably carbon dioxide.

## D. How do human activities lead to enhanced greenhouse effect?



## Human activities

- Burning fossil fuels
- Deforestation
- Changing land use
  - Agriculture
  - Industries
  - Urbanisation

### Burning fossil fuels

- Fossil fuels: formed from decomposition of dead organic matter over millions of years. For example, petroleum, coal and natural gas.
- Powers 80% of the world's energy
- Contains high carbon content, releases huge amount of carbon dioxide when burnt
- Highest contributor of greenhouse gases.

### Deforestation: Loss of forests due to the removal or clearance of trees in forested areas.

- Causes increase in levels of carbon dioxide in two ways:
  - Fewer trees to absorb carbon dioxide
  - Carbon oxidation: Carbon in soil reacts with oxygen to produce carbon dioxide, aided by higher temperatures when soil is exposed to sunlight.
- Reason for deforestation: the need of land for cattle ranching, soybean production, commercial logging and mining

### Changing land use: Agriculture

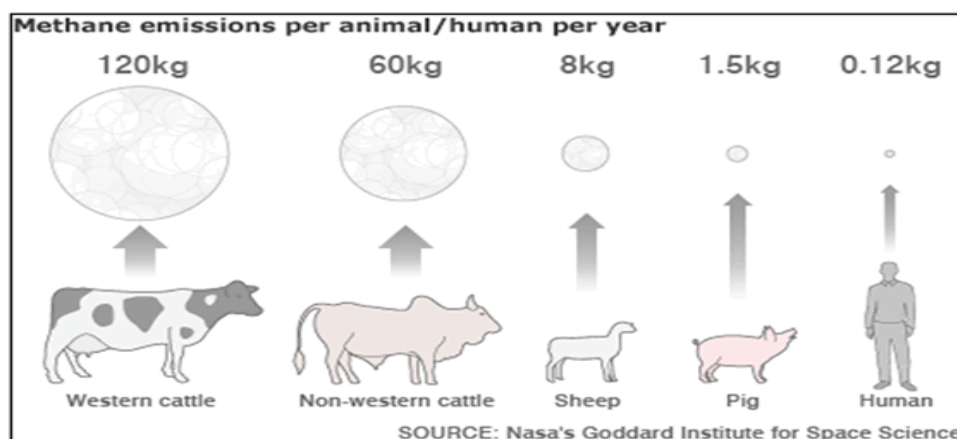
- Agriculture: Practice of cultivating land, producing crops and raising livestock.
- Cattle farming releases millions of tonnes of methane into the atmosphere annually, as gases are released from the digestive systems of cattle.

Tractors run on fossil fuels which release carbon dioxide.

The use of inorganic fertilisers increases the amount of nitrous oxide in soil. Nitrous oxide is released when soil is ploughed or when rain flows through the soil.



Organic matter such as dead leaves and manure releases methane during decomposition. Decomposition is very rapid in the rice fields due to the high level of moisture in the soil.

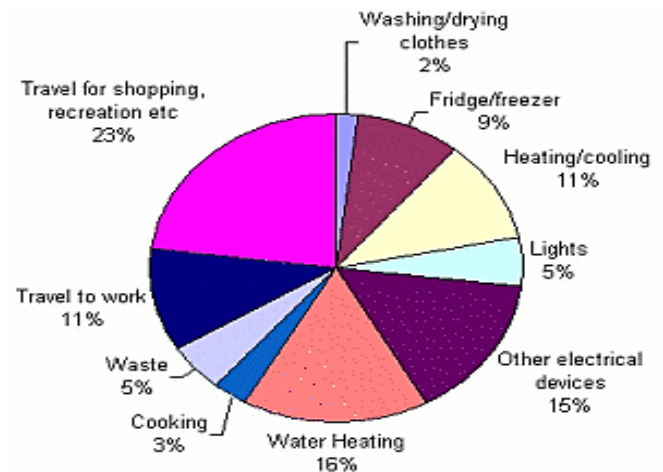


### Changing land use: Industries

- Industries: Production of goods and services within a country.
- Major contributor of carbon dioxide through the burning of fossil fuels to create energy needed to run industrial processes.

### Changing land use: Urbanisation

- Urbanisation: Process by which an increasing number of people live in urban areas.
- Various human activities are necessary in urban places. All of them contribute to the amount of greenhouse gases in the atmosphere.



### E. How does climate change affect people?

Four key impacts of climate change we will learn about:

- 1) Sea level rise
- 2) Frequent extreme weather events
- 3) Spread of infectious insect-borne diseases
- 4) Lengthening of growing season in certain regions

#### 1) Sea level rise

- Increase in the mean height of the sea's surface between high and low tide relative to land.
  - Higher temperature causes water to expand
  - Higher temperatures causes glaciers to melt, adding meltwater to the sea
- According to the Intergovernmental Panel on Climate Change, 33 per cent of coast land and wetland habitats are likely to be lost in the next hundred years if sea levels continue to rise at the current rates.

#### 2) Frequent extreme weather events

- Extreme weather events: severe and rare weather phenomenon that results in significant economic losses and the loss of lives
- When people are subject to extreme heat, vital organs are at risk and death results when the body cannot cool itself down sufficiently
- E.g. Heat waves, floods and tropical cyclones
- In August 2003, Europe experienced a heat wave which killed more than 70,000 people

#### 3) Spread of infectious insect-borne diseases

- Link between insect-borne diseases and climate change:
  - Increased rainfall and temperatures is favourable for mosquitoes to breed (allows spread of malaria and dengue fever)

#### 4) Lengthening of growing season in certain regions

- Higher temperatures have led to longer growing seasons for some regions.
  - Advantage (Cold regions are now warmer, more conducive for crop growing)

- i. Increase in types of crops, such as blackberries, that can be grown in UK.
- ii. Increase in fruit, soybeans and potatoes in Canada.
- Disadvantage (Cool regions are now getting hotter, less conducive for crop growing)
  - i. Apples and cherries production in Yunnan is reduced as they need cool conditions.
  - ii. Wheat yield has reduced in Canada.

**F. What are the responses to climate change?**

- International Level
  - Kyoto Protocol (1997)
- National Level
  - Singapore

**- International Level: Kyoto Protocol**

- Kyoto Protocol: An international agreement to reduce greenhouse gases emissions into the atmosphere.
  - Drawn up on 11/12/97, came into effect 16/02/05
  - Different countries have different targets to hit and progress of carbon emissions will be reported for review.

Successes

- Many countries met or exceeded targets set by Kyoto Protocol as there was constant monitoring and reporting by countries for self-assessment, such as Finland.
- Encouraged sustainable development.
- Developed countries are encouraged to work with less-developed countries in carbon-reducing projects (Clean Development Mechanism — CDM)

Limitations

- Not all countries are able to meet their targets and not all countries have the same emission targets.
- Denmark, Sweden and the United Kingdom did not achieve their targets
- Many countries did not sign the Kyoto Protocol and continue to contribute to global emissions.
- A large portion of the increase in global emissions (by 35%) came from China, India and the United States of America

**- National Level: Singapore**

1) Singapore Green Plan 2012

- Reduce energy consumption and greenhouse emission from burning fossil fuels

| Description of strategy                                                                                                                                                                                                                            | Successes                                                                                                                                                                  | Limitations                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Launched by the Ministry of the Environment in 2002, the Plan aims to generate 60 per cent of Singapore's energy needs using natural gas by 2012. Natural gas is a cleaner form of energy in comparison to coal because it does not produce smoke. | As early as 2010, about 79 per cent of Singapore's electricity was being generated from natural gas. This exceeded the Ministry of Environment's target ahead of schedule. | Natural gas requires complex treatment plants to process and pipelines to transport. These pipelines have high maintenance costs because they need to be laid underground and have to be checked regularly for leakage. |



## 2) Green Mark Scheme

- Constructing 'green' buildings

| Description of strategy                                                                                                                                                                                                                                                                                                                                                                                                                            | Successes                                                                                                                                                                                                                                                                                                                 | Limitations                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| Launched by the Building Construction Authority (BCA) in 2005, the scheme allows buildings to be evaluated and certified according to how energy-efficient and environmentally friendly they are. The scheme aims to encourage more new 'green' buildings, which are more energy-efficient. Buildings which are more <b>energy-efficient</b> use less energy to provide the same service. An example is buildings that run partly on solar energy. | Existing 'green' buildings, such as Plaza by the Park, Standard Chartered @ Changi and the National Library Building, have reported energy savings of 15 per cent to 35 per cent compared to conventional buildings. This cuts down greenhouse gas emissions by reducing the use of fossil fuels to generate electricity. | Construction companies and developers in Singapore tend to be conservative about adopting new ideas and materials to build 'green' buildings. 'Green' buildings are built using processes that are environmentally friendly and resource-efficient.<br><br>'Green' buildings may cost more to build because 'green' materials may be more expensive. 'Green materials' are products such as bamboo or recycled metal that are non-toxic, reuseable, renewable, or recyclable. |

## 3) Plant-A-Tree programme

- Planting more trees and plants

| Description of strategy                                                                                                                                                                                                                                                                                                                      | Successes                                                                                                                                                                                                                            | Limitations                                                                                                                                                                                                                                                     |
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| Started in 1971 as Tree Planting Day, the Plant-A-Tree Programme by the Garden City Fund and Singapore Environment Council aims to maintain Singapore's status as a Garden City by planting trees. Residents are encouraged to donate money to buy a tree or take part in tree planting events that take place monthly throughout Singapore. | The programme has contributed to an estimated 60,000 trees planted yearly throughout Singapore by the National Parks Board (NParks). Trees are the green lungs of the environment as they remove carbon dioxide from the atmosphere. | Trees take many years to mature, so the positive effects of tree planting will take time to materialise. Even relatively fast-growing trees such as angsanas, raintrees and yellow flames that were planted by NParks took 25 years to reach their full height. |