GEOACTIVE 564

Climate change – adaptation and mitigation

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A case study about ...

Throughout history, people and societies have responded to and coped with changes in climate with varying degrees of success.

Managing climate change involves both reducing the causes (mitigation), and responding to the effects (adaptation). Several case studies in this unit show how different parts of the world are currently trying to go some way towards managing the changes brought by climate change.

Key vocabulary

climate change, anthropogenic, mitigation, adaptation, sources, stores, resilience

Learning outcome

In this unit you will learn about:

- the greenhouse effect and how humans are enhancing it to bring about changes in our climate
- the management of climate change and how it involves both mitigation and adaptation strategies
- various case study examples to illustrate the implementation of both mitigation and adaptation strategies to manage climate change around the world.

Relevance to specifications

Exam board	Link to specification
AQA	Paper 1: Living with the physical environment, Section A: The challenge of natural hazards, see page 12. Click here
Cambridge IGCSE	Theme 3: Economic development, Topic 3.7: Environmental risks of economic development, see page 14. Click here
Edexcel A	Component 1: The physical environment, Topic 2: Weather hazards and climate change, see pages 12–13. Component 1: The physical environment, Topic 3: Ecosystems, biodiversity and management, see pages 14–15. Component 2: The human environment, Topic 6A: Energy resource management, see pages 23–24. Click here
Edexcel B	Component 1: Global geographical issues, Topic 1: Hazardous Earth, see page 9. Click here
Edexcel IGCSE	Section A: The natural environment, Topic 3: Hazardous environments, see page 8. Click here
Eduqas A	Component 2: Environmental and development issues, Theme 8: Environmental challenges, see page 21. Click here
Eduqas B	Component 1: Investigating geographical issues, Theme 2: Changing environments, see pages 13 and 16. Click here
OCR A	Component 2: The world around us, 2.3 Environmental threats to our planet, see page 12. Click here
OCR B	Component 1: Our natural world, Topic 2: Changing climate, see page 8. Click here
WJEC A	Unit 1: The core, Theme 2: Climate change, see page 15. Click here
WJEC B	Theme 3: Uneven development and sustainable environments, Key idea 3: Economic activity and the environment, see page 21. Click here

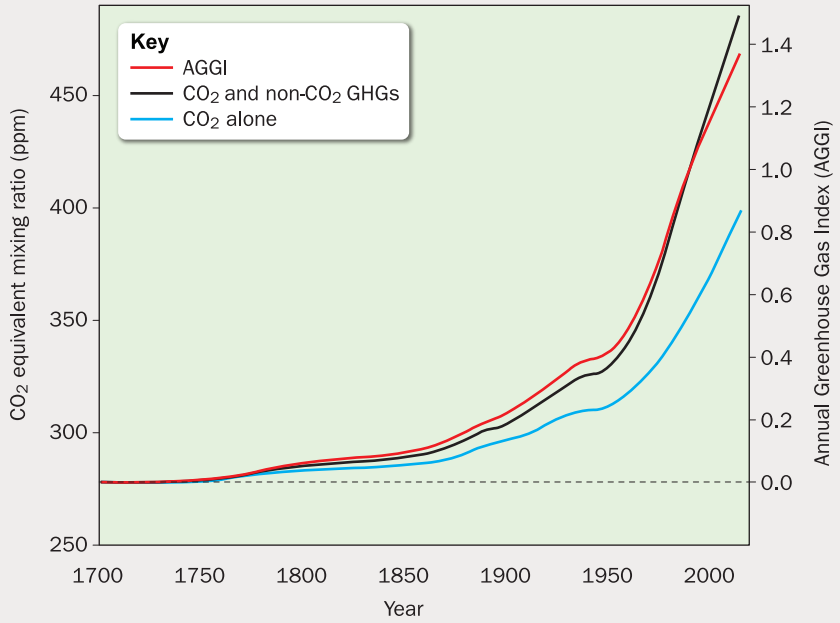
Climate change – adaptation and mitigation

Climate change refers to significant and long-lasting changes to the weather systems of our planet. Evidence for these changes can be seen across our climate system including increased temperatures, shrinking glaciers and reducing Arctic sea ice.

> "Our planet is only able to support life as we know it because of the greenhouse effect."

It is important to know that our planet is only able to support life as we know it because of the greenhouse effect which is a natural process that traps some of the heat lost from the Earth's surface in the atmosphere (Figure 1).

Since the start of the industrial revolution, activities such as the burning of fossil fuels have been enhancing the greenhouse effect by increasing the concentration of greenhouse gases (GHGs) in our atmosphere (Figure 2). Scientific research has shown that the average temperature of the planet's surface rose by 0.89°C between 1901 and 2012. When compared with climate change patterns throughout Earth's history, this rate of temperature increase is extremely high.



1750 is the pre-industrial baseline.
The AGGI is a measure of the warming influence of long-lived trace gases and how that influence is changing each year.

Figure 2 Atmospheric GHG concentration since 1750
Source: NOAA

> "The average temperature of the planet's surface rose by 0.89°C between 1901 and 2012."

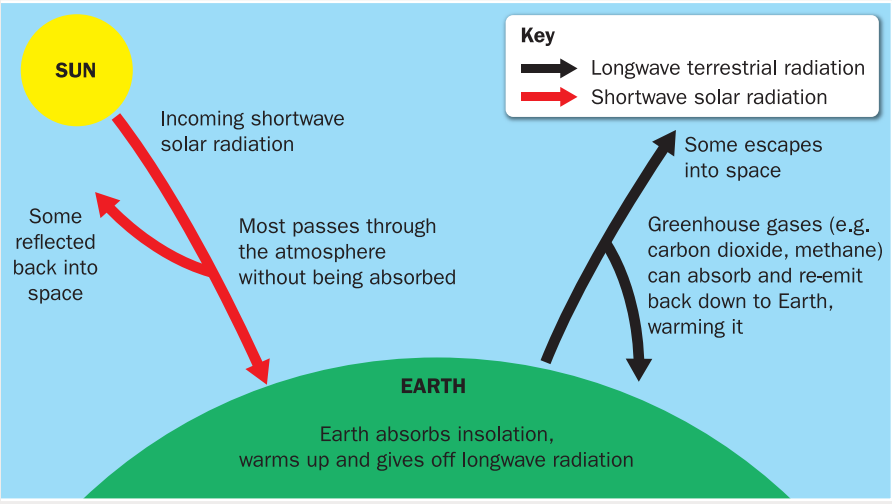


Figure 1 The greenhouse effect

Human influence

In 2013, the Inter-governmental Panel on Climate Change (IPCC) published its fifth assessment report in 23 years. The IPCC is a small organisation based in Geneva and its reports draw upon the work of over 800 scientists.

The report concluded that human (**anthropogenic**) changes to the composition of the atmosphere caused more than half of the observed increase in global mean surface temperatures since the 1950s. Atmospheric

concentrations of the GHGs carbon dioxide, methane and nitrous oxide were recorded at levels unprecedented in at least the last 800 000 years.

These emissions will continue to affect our climate for many decades to come and a certain amount of further warming is inevitable because of the long lifespan of carbon dioxide in the atmosphere. Crucially, however, if emissions are reduced early and rapidly the extent of climate change can be reduced.

Managing climate change

Managing climate change involves both reducing the causes (**mitigation**) and responding to the changes (**adaptation**):

- Dangerous and unpredictable changes are projected unless warming is limited to 2°C (compared with pre-industrial levels).
- At the current rate, this means only another 15 to 20 years of global GHG emissions and if emissions continue to rise, temperatures could increase by 4°C by the end of the century, which is very worrying

Early and rapid reductions in GHGs could produce significantly lower levels and reduce the temperature rise projected to occur by 2100 and beyond. However, an immediate and collective shift in all nations' energy policies would be required which could severely affect the global economy, impairing the advancement of the developing world.

Mitigation strategies

Mitigation is an attempt to limit the amount of climate change by either:

- reducing the **sources** of GHGs – for example, reducing the burning of fossil fuels (coal, oil or gas)
- or enhancing the **stores** of GHGs – for example, by planting trees.

> "Climate change mitigation requires international cooperation."

Climate change mitigation requires international cooperation. Effective mitigation will not be achieved if individual countries or groups advance their own interests independently.

In December 2015 in Paris, a deal was struck that unites all the world's nations in a single agreement on tackling climate change for the first time in history.

- All 195 countries agreed to peak GHG emissions as soon as possible.
- Each country's contribution to cutting emissions would be reviewed every five years to ensure that they keep on top of the challenge.
- Developed nations are to provide climate finance to help developing countries leapfrog fossil fuels and move straight to renewables. Some $100 billion a year by 2020 has been promised.

Further mitigation strategies include the promotion of alternative energy sources other than fossil fuels (Case study 1) and carbon capture and storage (Case study 2).

Adaptation strategies

Adaptation is the process of adjustment to actual or expected climate change and its effects. Governments are beginning to develop adaptation plans and policies and to integrate climate change considerations into broader development campaigns (Case studies 3 and 4). However, responding to climate-related risks involves decision making in an uncertain, changing world, and there are limits to the effectiveness of adaptation.

Case study 1: India

India is a rapidly developing country with over 1 billion people. It is trying to increase the use of solar power in industry in order to reduce the reliance on burning fossil fuels as an energy source:

- India has tremendous solar energy potential, receiving nearly 3000 hours of sunshine every year.
- India can generate over 1900 billion units of solar power annually, which should be enough to

service the entire annual power demand even in 2030 (Figure 3).

- However, renewable energy currently supplies only 7.7% of India's power, mostly through wind.
- Current limits to the growth of the solar industry are financial, largely due to the high price of imported silicon, the material that solar cells are made from.

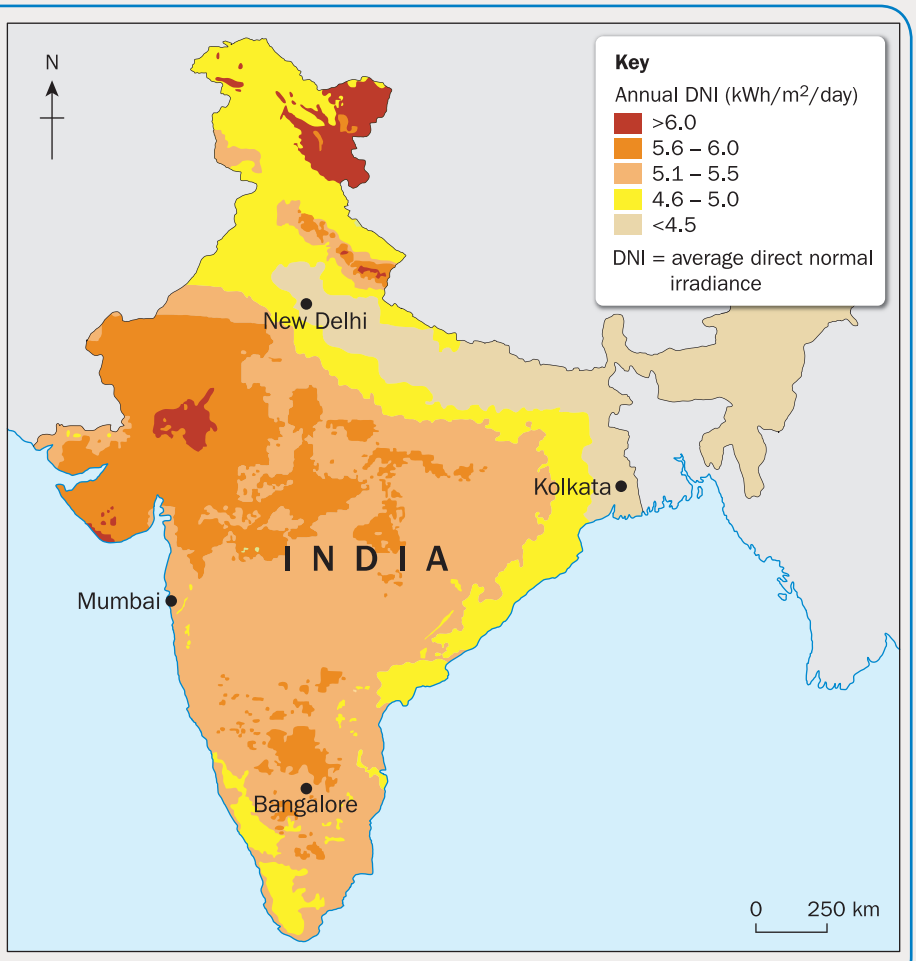


Figure 3 India: potential for solar energy
Source: National Renewable Energy Laboratory
http://mnre.gov.in/sec/DNI_Annual.jpg

Case study 2: UK

Carbon capture and storage (CCS) involves capturing carbon dioxide from sources such as fossil fuel power stations and storing it deep underground to avoid it entering the atmosphere (Figure 4).

However, the process is expensive and it is estimated it would cost as much as £1 billion to install in each of Britain's existing fossil fuel power stations.

The IPCC deems CCS extremely important and estimates that the costs of halting anthropogenic climate change would double without CCS.

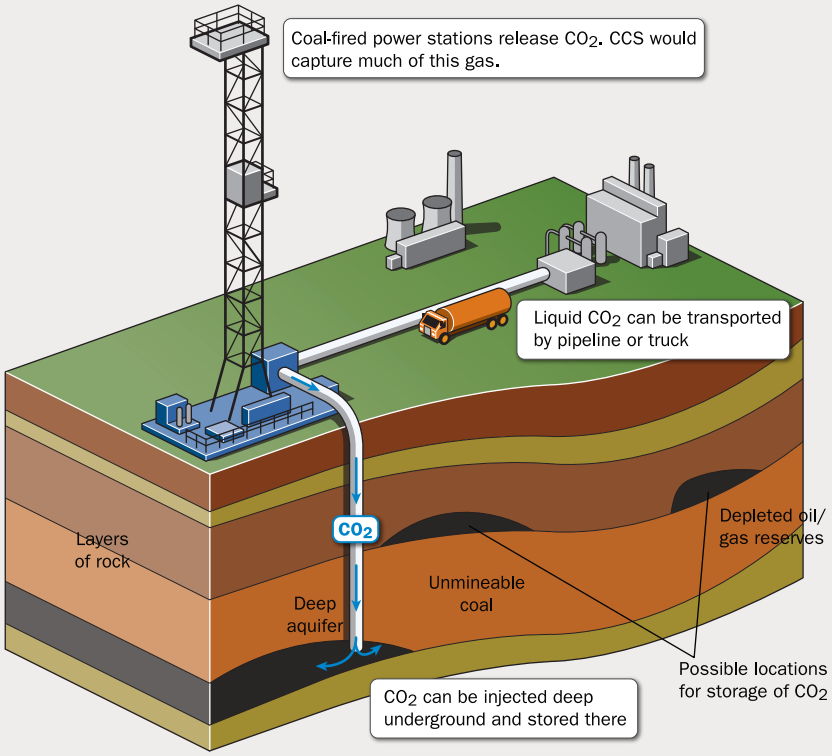


Figure 4 Carbon capture and storage

Case study 3: Denmark

On 2 July 2011, more than 150 mm of rain fell in two hours flooding the centre of Copenhagen. Over €1 billion of insurance claims were made in the city from this single cloudburst event.

This event prompted Copenhagen to launch a climate adaptation plan. This set aside €1.3 billion to install new engineering solutions over the next 20 years.

- Cloudburst boulevards would be constructed to direct water to drier areas. In dry weather these canals would be used as cycle paths, and in some cases roads, but would purposefully fill with water during floods.
- Pocket parks would be created to store surplus water. These large green spaces would provide recreational areas between floods but fill with water when required.
- The city would also be bisected by a cloudburst tunnel. Its aim is to keep rainwater out of the drainage system and stop it emptying into other parts of the city too quickly.

The plan aims to bring about a better quality of life for residents through:

- improved access through the city
- greener recreational space
- air pollution removal
- added value to house prices as a result of increased flood protection.

The people of Copenhagen were asked to pay for the scheme through a 10% increase in their water bills.

Case study 4: Bangladesh

With 70% of the country lying less than 1 metre above sea level, Bangladesh is inherently prone to flooding. Many areas experience extensive flooding during the monsoon season.

Bangladeshis are already preparing for a climate-changed future:

- For decades, the country has been developing more salt-resistant strains of rice and building protective dikes. As a result, the country has doubled its production of rice since the early 1970s.
- Where the ground is too salty to grow rice, farmers now raise shrimp in these brackish swamps, and grow vegetables higher up on the banks.
- Several communities have set up floating schools, hospitals and libraries which can function through periods of intense flooding. They are masters of climate **resilience**.

Conclusion

International agreement is essential to managing climate change across the world.

- Intervention must take place immediately.
- The extent and severity of future change will need to be regularly assessed to ensure that policy keeps up with the challenges ahead.
- All nations must be held accountable for their actions, with developing nations being given support to manage their climate campaigns.
- Adaptation must aim not only to moderate or avoid harm, but also to harness change for positive societal gains.

Effective management of climate change will not only ensure that normal life continues, but also aim for an overall improvement to global society.

Activities

1 a Write a sequence of numbered statements to help explain the greenhouse effect.

b How can humans enhance this natural process?

c Explore the British Geological Survey webpage on man-made sources of greenhouse gases:

www.bgs.ac.uk/discoveringGeology/climateChange/CCS/Anthropogenic.html

d Using this research, add the main man-made (anthropogenic) sources of greenhouse gases to a large copy of Figure 1 to help show how humans can enhance the greenhouse effect.

2 a How can alternative energy production in India help limit the amount of climate change?

b Explain how carbon capture and storage works.

c What issues need to be overcome in order for carbon capture and storage to be widely used in the future?

d Why is international cooperation essential for effective mitigation?

3 a Explain how cloudburst boulevards, tunnels and pockets parks will help Copenhagen to adapt to changes in our climate.

b Do you think it is fair that the people of Copenhagen are being asked to pay for the adaptation plan through a 10% rise in their water bills? Justify your opinion.

c How are farmers in Bangladesh adapting to the possible impacts of climate change?

4 Working in groups, explain why both mitigation and adaptation are needed to manage climate change.

Learning checkpoint

- Since the start of the industrial revolution, activities such as the burning of fossil fuels have been enhancing the greenhouse effect by increasing the concentration of GHGs in our atmosphere.
- Scientific research has shown that the average temperature of the planet's surface rose by 0.89°C between 1901 and 2012.
- Dangerous and unpredictable changes are projected unless warming is limited to 2°C (compared with pre-industrial levels).
- At the current rate, this means only another 15 to 20 years of global GHG emissions and if emissions continue to rise, temperatures could increase by 4°C by the end of the century.

Glossary task

Write glossary definitions for these terms:

Adaptation	**Resilience**
Anthropogenic	**Sources**
Climate change	**Stores**
Mitigation	

Remember this case study

To help you remember this case study, make notes under the following headings:

What is the greenhouse effect?

How are humans enhancing the greenhouse effect?

How can we mitigate the causes of climate change?

How can we adapt to climate change?

What is required to ensure effective management of climate change?

Try to make your notes fit a single sheet of A4.