

Exploring how humans affect the carbon cycle

We are learning how to:

- Understand that human activities affect the carbon cycle.
- Appreciate the scale of this impact.
- Explain how the impact relates to carbon stores as well as carbon dioxide producers.

We don't just live on the Earth – we change it. The Earth is a different place because of humans. We have changed the atmosphere, the seas and the surface of the land in many places. Thanks to us, some animals are much less common and others much more so. One of the things we have changed is the way that carbon is cycled.

Humans make a difference

If we were to do something fairly common, such as go to the garage, fill our car up with fuel and use it to go for a day out, we have affected the carbon cycle. The fuel that we put in the car was made using oil, a **fossil fuel**. By using this we have reduced the amount of oil left.

Driving the car involved burning the fuel. It used the process of **combustion**. This added to the amount of carbon dioxide in the atmosphere.

In fact, simply by eating and breathing, we have moved carbon around its cycle. We have eaten food (which grew, or which ate something that grew). This decreased the number of plants and we breathed out carbon dioxide.



FIGURE 2.7.3a: Filling up the car – how does this affect the carbon cycle?

1. Would it have made any difference to the carbon cycle if our day out had been:
 - a) by bus?
 - b) by electric train?
2. Why does it matter if there's more carbon dioxide in the atmosphere?
3. How do farm animals affect the carbon cycle?

The carbon cycle existed long before humans did of course, and there have been animals (and plants) respiring for millions of years before humans first walked on the surface of the Earth. In fact, for many years, people didn't affect the movement of carbon much. All that has changed in the last few hundred years.

We have used up a huge amount of the available fossil fuels through burning them and this has released large volumes of carbon dioxide into the atmosphere. These fuels have been used to provide transport, generate electricity and power factories to make things.

We have also changed the way that we use land. Large areas have been cleared of natural **vegetation**. The dense growth that has been removed stored much more carbon than the crops planted in their place.

4. Why have most of these changes only happened within the last few hundred years?
5. Why have we cleared large amounts of land over the years?
6. How has population growth affected land usage?

Increased sources – and reduced stores

Not only have we added to the processes that produce carbon dioxide, but also we have reduced the ways that it is removed. Looking at the carbon cycle, the way that carbon dioxide is removed from the atmosphere is by **photosynthesis**. Plants use carbon dioxide in the process of releasing energy from sunlight. If we grow, or allow to grow, fewer plants or smaller plants, their need for carbon dioxide is less.

7. Why is photosynthesis crucial to the carbon cycle?
8. How have humans affected the way that nature removes carbon dioxide from the atmosphere?
9. Why is this something we should be concerned about?



FIGURE 2.7.3b: Palm oil plants growing in areas where rain forest has been cleared.

Did you know...?

Burning one litre of petrol (such as in a car engine) produces 2.4 kg of carbon dioxide. This amount of fuel will enable a small modern car to travel about 20 km.

Know this vocabulary

fossil fuel
combustion
vegetation
photosynthesis

Understanding global warming

We are learning how to:

- Describe the effects of global warming.
- Explain the consequences of global warming for living things.
- Evaluate the arguments for human activity impacting global warming.

The greenhouse effect is a natural phenomenon that allows the Earth to be warm enough to support life. Without it the average temperature of the Earth would be -18°C . What causes the greenhouse effect and how does human activity affect it?

What is global warming?

The Sun's radiation passes through the atmosphere, is absorbed by the Earth's surface and is re-radiated as heat. Some of this heat is absorbed or reflected by greenhouse gases in the air instead of escaping into space, causing the atmosphere to warm up.

Human activities have caused higher **concentrations** of greenhouse gases in the atmosphere. Scientists think that this increase has thrown the natural **greenhouse effect** out of balance. The atmosphere is trapping too much heat and causing the temperature of the Earth to rise. This is known as the 'enhanced greenhouse effect' or **global warming**.

1. What is the natural greenhouse effect and why is it important for life on Earth?
2. Name three greenhouse gases and identify where they come from.

The impact of global warming

A rise in the global mean temperature will cause climate change, which may result in:

- polar ice sheets melting, causing sea levels to rise, low-lying areas of the world becoming submerged and habitat loss for many species
- some areas having less available water, causing food shortages, drought and desertification of land
- longer growing seasons in temperate regions and faster growth for some crop species due to increased carbon dioxide concentrations

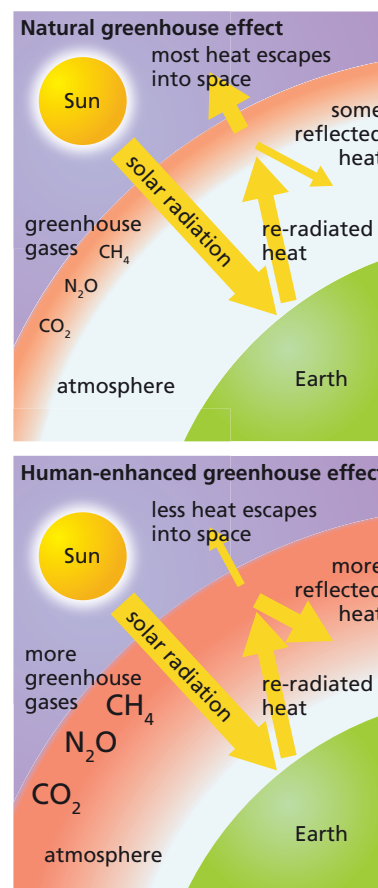


FIGURE 2.7.4a: Comparing natural and human-induced greenhouse effects, including the role of carbon dioxide (CO₂), nitrogen oxides (N₂O) and methane (CH₄).

- agricultural pests thriving in warmer environments
- tropical diseases, for example malaria, affecting a larger area
- an increase in severe weather events.

Scientists agree that the Earth's temperature has risen over the last century and that carbon dioxide is one of the greenhouse gases that cause global warming. Some disagree over whether global climate change is part of a normal cycle or not, and about how big a problem it could become.

3. Explain how global warming might affect polar bears, penguins and mosquitoes.
4. Suggest how global warming might affect global food security.

Are we to blame?

The Earth's average temperature increased by about 0.5°C over the last century. It is projected to rise between 1.4°C and 5.8°C in the next 100 years. The Earth's climate has changed naturally throughout its history, but the current rate of change has not been seen in the last 10000 years.

Most research shows that human activities are accelerating global warming.

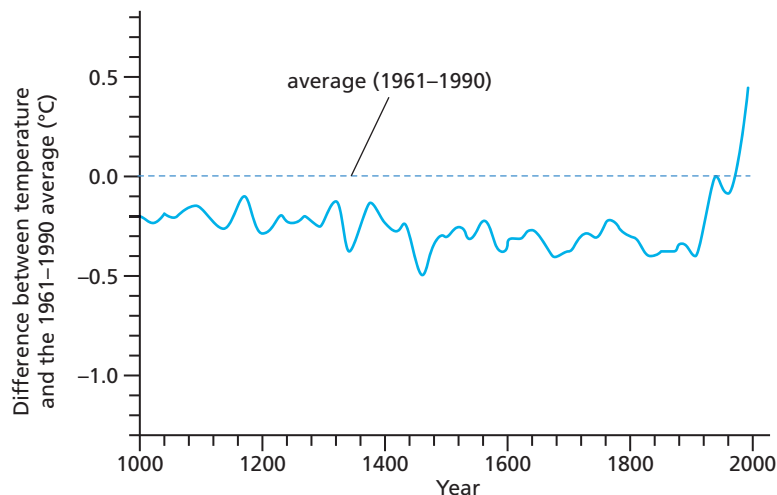


FIGURE 2.7.4c: A graph showing climate change using data from The Intergovernmental Panel on Climate Change (IPCC).

5. Explain why scientists believe that global warming is happening.
6. Look at the data in the graph in Figure 2.7.4c. Describe what the graph shows. What conclusions can you draw about global warming from the data?

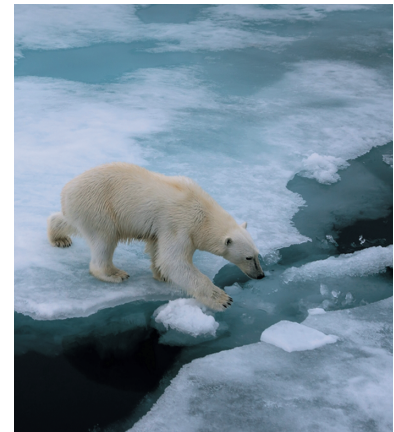


FIGURE 2.7.4b: If the polar ice caps melt, will the wildlife survive?

Did you know...?

The United Nations Sustainable Development Goals are an internationally agreed set of goals focused on making better and fairer use of the Earth's resources by 2030.

They include Goal 17: Take urgent action to combat climate change and its impacts.

Know this vocabulary

concentration
greenhouse effect
global warming

Exploring damage to the Earth's resources

We are learning how to:

- Describe resources that the Earth provides.
- Explain how human activity limits these resources.
- Justify decisions about making changes to the environment.

The Earth has limited resources that we rely on for survival. How have our activities affected these resources? How can we protect them for the future?

The Earth's vital resources

The Sun's energy, the wind, the tides and geothermal heat are some of the Earth's **natural resources** that you have already studied. The Earth provides many other resources, from the air we breathe and the wood and rocks used for building, to the minerals that we refine into metals. Life as we know it would not be possible without these precious resources, but as we process them, pollution is produced.

Other natural resources that are vital to our survival include:

- biological resources (plants and animals)
- land
- fossil fuels
- metal ores
- water.



FIGURE 2.7.5a: Which natural resources can be seen here?

Natural resources are often classified as **renewable** or **non-renewable resources**.

1. Choose six natural resources. Describe why we need each one and how we use it.
2. Classify each of the resources identified in question 1 as renewable or non-renewable.

Did you know...?

Water is abundant on the Earth, but 97 per cent of the water is salt water in the oceans. Only 3 per cent is in fresh water lakes and rivers.

As the human population increases, so do pollution and environmental damage. Developed countries use the majority of the world's resources. About 25 per cent of the world's population are causing 75 per cent of the damage to the environment. Areas that are most vulnerable to damage are those that are easily accessible and supply natural resources that are in high demand.

Mining provides precious gems, coal for making electricity, and ores from which metals are extracted. It also causes pollution and leaves scars on the landscape. This environmental impact means that the mining is not **sustainable**. Other examples of unsustainable activities are oil extraction, deforestation, over-fishing the seas and intensive farming (producing more food from the same area of land). To get the most out of their land, farmers who use intensive farming sometimes cut down hedgerows, which results in habitat loss and affects food chains. They also use chemicals – for example, pesticides and fertilisers, which pollute the land and waterways, killing organisms and disrupting food chains.

3. Why are some natural resources more vulnerable to human activities than others?
4. Look at Figure 2.7.5b. How has this damage occurred?

Making sustainable decisions

Deforestation in the Amazon rainforest is becoming a major issue. Huge areas of the rainforest are cleared annually to:

- increase the land available for farming soya and cattle
- allow mining
- flood the land for use in hydro electric power stations
- sell the timber.

However, once the trees have been cut down, the soil quickly becomes less fertile, making farming difficult. Wildlife is lost and local tribespeople are forced off the land and lose their traditional cultures. Global impacts include loss of biodiversity (including valuable medicinal or crop plants) and increased carbon dioxide levels in the atmosphere.

5. Explain why there has been a loss of biodiversity in the Amazon.
6. Suggest how we could manage the Amazon's resources in a more sustainable way.



FIGURE 2.7.5b: Drainage from surface coal mines can pollute nearby streams.



FIGURE 2.7.5c: The lush biodiversity of the Amazon rainforests is being destroyed.

Know this vocabulary

natural resource
renewable
non-renewable
sustainable

Considering the importance of recycling

We are learning how to:

- Describe examples of recycling.
- Explain the benefits and limitations of recycling schemes.
- Compare the efficiency of recycling methods.

Recycling is the collection and processing of waste materials to make new products. What materials can be recycled and why do we recycle?

Why recycle?

UK households produce about 82 000 tonnes of rubbish every day. Each week, a typical family in England or Wales uses an average of:

- 7 glass bottles or jars
- 14 food or drinks cans
- 8 plastic bottles
- 4 kilograms of paper.

Continuing to burn or dump this amount of rubbish is unsustainable – **recycling** is a sustainable alternative. It reduces the demand for natural resources, including fossil fuels. It also causes less pollution and release of greenhouse gases, and less waste is sent to **landfill**.

Many materials can be recycled, including batteries, mobile phones, clothes and wood. Currently we recycle about 43 per cent of our household waste, though this varies across the country.

1. Name ten materials that can be recycled.
2. Use Table 2.7.6a to draw a bar chart showing the time taken for different materials to decompose.
3. Suggest why paper milk cartons take so long to decompose.

The limitations of recycling

Disadvantages of recycling are that recycling sites can produce pollution and they may be unsafe and unhygienic. The initial costs of recycling plants can be very high and some processes use a lot of energy. The separation of useful



FIGURE 2.7.6a: How do landfill sites damage the environment?

TABLE 2.7.6a: Some materials take hundreds of years to decompose.

Material	Time taken to decompose
paper	2–4 weeks
paper milk cartons	5 years
plastic bags	1020 years
cans	100 years
plastic bottles	450 years
glass bottles	500 years
rubber	80–2000 years

material from waste can be difficult and recycled products are often not high quality (for example, paper) or durable (for example, textiles). Finally, many of the resources saved are not that rare.

4. Why is reducing the demand for natural resources an advantage of recycling?
5. Suggest why recycling sites may be unsafe and unhygienic.

Making sustainable decisions

There is much debate over the efficiency of recycling. Experts have conducted detailed life cycle analysis of recycled goods, estimating the energy used from collecting to processing. The efficiency compared to using new raw materials varies dramatically depending on the material. However, in most cases the energy needed to extract and process natural resources is much higher than that used to recycle the same material. Recycling therefore reduces the negative impact on the environment.

Recycling materials like metals and glass is fairly efficient. However, some materials have to be **'down-cycled'** into products that cannot themselves be recycled. For example, soft-drink bottles made from PET (a plastic) end up as polyester fibres in clothes or carpets.

There is no economic incentive for people to recycle – the cost is zero for the consumer whether they throw their rubbish away or recycle it. The industry has therefore struggled for consistent amounts of materials to recycle. China now imports vast amounts of waste in order to recycle things like paper.

TABLE 2.7.6b: How much more efficient is aluminium recycling compared to glass recycling?

Material	Reduction in energy needed to recycle rather than use raw material (%)
aluminium	96
glass	21
plastic	76
newsprint	45

6. Explain why it is efficient to recycle aluminium.
7. Suggest why China imports waste paper to recycle.



FIGURE 2.7.6b: Why is this worker at a recycling plant wearing a mask?

Did you know...?

In Brazil old car tyres are cut up to make the soles for beach sandals. The rubber is hard wearing, waterproof and gives a good grip.

Know this vocabulary

recycling
landfill
down-cycle