

Moving carbon

– adapted by Westonbirt education staff from a Forest Stewardship Council (FSC) activity

Learners will have/be able to:

- Explain the process of respiration common to plants and animals, and photosynthesis in plants
- Describe the splitting of carbon dioxide into its component parts – carbon atoms and oxygen molecules
- Explain the term ‘carbon balance’, ‘carbonneutral’ and ‘carbon lean’ and give an example
- Explain why deforestation is more harmful for climate change than sustainable management and reforestation
- Contributed to working/learning as a team and/or as an individual

A flat outdoor space in a woodland/ school grounds

‘Animals of the world’ and ‘People of the world’ laminated cards – large - to be hung round neck – one of each

‘Forests of the world’ Laminated card – to be hung round neck – five cards

Empty grass baskets 12 – IKEA type

Carbon atom cards Large white laminated card circles/squares with 2 self adhesive strips of Velcro hoops - 80

Oxygen atom cards Small blue laminated card circles/squares with one self adhesive strip of Velcro hooks - 80

Carbon dioxide emitters Laminated cards with ‘Factory’ (2), ‘transport’ (2), ‘homes’ (2), ‘farming’ (2) on strings to hang round necks

Forestry Commission Scotland

15 minute film *Forests and climate change: a convenient truth* – on website – learning resources
www.forestry.gov.uk/scotland

Forest Stewardship Council

The Forest Summit activity - www.fsc-uk.org - go to education>activity ideas>the forest summit

This is a running game demonstrating the different impacts on climate change, as a consequence of different choices people make in managing the forest resource.

It is not as complicated as it looks - just requires learners to concentrate on what is happening!

Preparatory activity

Having seen the video and/or the section on deforestation in *Forests and Climate Change: a convenient truth* film – see Sources and further Inspiration, consider what kinds of things control what choices we make – whether exploitation/ sustainable management – in the UK, elsewhere in the world where deforestation is taking place.



Activity 2

01 STEP 1 Setting the scene

Explain that in the last 10, 000 years, since the Last Ice Age, across what is Europe today, forests have grown and covered much of the land area. Wild animals and humans/ people lived in and off, and travelled in and through, these forests. All animals and plants (including humans/people) breathe in oxygen (O_2) from the atmosphere and breathe out carbon dioxide (CO_2). This is called **respiration** whereas, all plants – from trees to algae – during the day, take in carbon dioxide (CO_2) from, and release oxygen (O_2), back into the atmosphere. This is called **photosynthesis**.

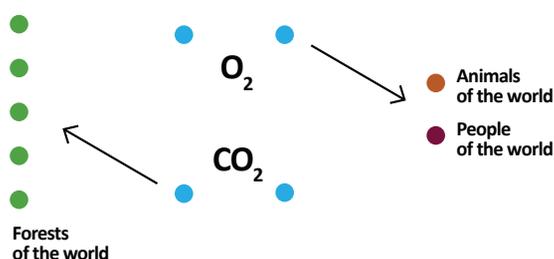
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As human populations have grown, the pressure on forests has grown. As a result of the choices humans have made in managing/using and caring for the forests there have been consequences for the balance of these gases in the atmosphere. This game looks at the consequences for forests and climate change of these different choices in behaviour, over time.

To set the scene, invite a small group of volunteers to demonstrate:

- 1 volunteer – represents the wild ‘animals of the world’ (needs a stock of carbon atom cards)
- 1 volunteer – represents the human population – ‘people of the world’ (needs a stock of carbon atom cards)
- 5 volunteers – represent the ‘forests of the world’ (each needs a basket)
- 4 volunteers – ‘atmosphere’ – 2 of them start as/with carbon dioxide CO_2 , the other 2 start as oxygen O_2 molecule cards

Ask everyone to listen and watch very closely as we walk through the actions, and then we’ll play the game fast time!



To start the game off - Line up the volunteers as illustrated in the diagram. Then addressing everyone, ask the two ‘atmosphere’ players carrying the O_2 molecule cards, to **walk** towards one of the ‘animals of the world’ or ‘people of the world’ who takes their molecule cards from them (i.e. **breathing in**). The ‘animals / people of the world’ are then asked to create a CO_2 molecule by attaching one of their carbon atom cards to the O_2 cards - they then hand the carbon dioxide CO_2 molecule back to the ‘atmosphere’ player (i.e. **breathing out**), and the ‘atmosphere’ players then walk back towards the ‘forests of the world’. Stop the play at halfway. You may wish to reinforce this process as **respiration**, and discuss what organs animals have for gas exchange.

Now demonstrate what the ‘atmosphere’ players do who are carrying CO_2 . They **walk** to the ‘forests of the world’ who take their CO_2 molecule cards from them (**absorbing the CO_2** through the leaf stomata). The ‘forests of the world’ detach the pieces, store the carbon in the tree (placing the carbon atom card in the basket at their feet), and give the remaining oxygen molecule card (O_2) back to the ‘atmosphere’ player. The ‘atmosphere’ player then **walks** back towards the ‘animals of the world’ and ‘people of the world’. Stop the play at halfway. You may wish to reinforce this process as **photosynthesis**, and show the stomata on the underside of leaves, where this exchange takes place. Be sure to explain that plants **respire** at night.

Step 2 Carbon cycle in balance

Now explain that the content of gases in the atmosphere is constantly changing due to these gas exchange processes taking place. What does this mean for our players? It means in this game the ‘atmosphere’ players are continually cycling/running back and forth between the ‘forests of the world’ and the ‘animals / people of the world’, becoming O_2 , then CO_2 , back to O_2 and so on.

Ask the ‘atmosphere’ players to run through 2-3 cycles for everyone to get the idea. Either swap the volunteers over at this stage, and let everyone have a go, or move on (depending on time/ability of group).

CONSEQUENCES – Until recent centuries there was a ‘carbon neutral’ situation. The size, choices and behaviour of the Earth’s human population are now suspected to have affected the balance of gases in the atmosphere, more significantly since the Industrial Revolution in the UK, during the 19th and 20th centuries – influencing the nature of climate change.

continued overleaf >

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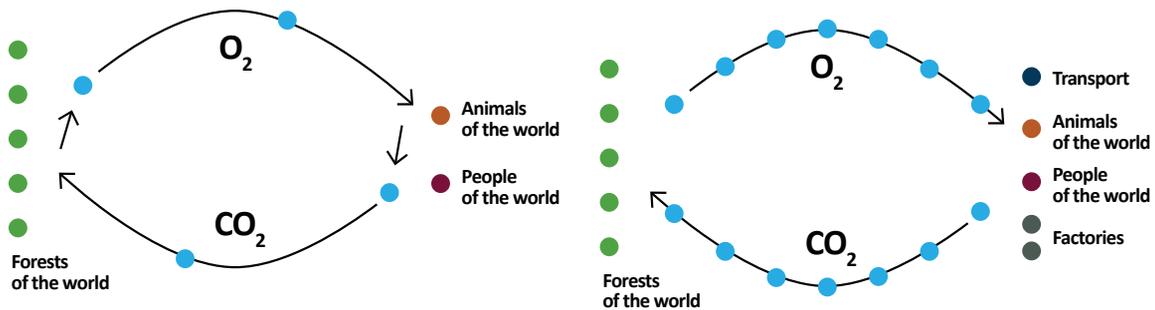
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Activity 2 continued...

STEP 2 Carbon cycle in balance



07 STEP 3 Burning fossil fuels

Explain that as time passed humans increased in number. They developed technology - the use of tools and fire, and much later technologies associated with fossil fuels, such as coal, oil and gas. During the 19th and 20th centuries many things were invented that needed fossil fuels to be burned to provide the energy to make them work. When fuel (carbon rich) is burnt, O_2 is drawn in and CO_2 released into the air. Time to get everyone involved!

08 Now, this time, we add in 2 volunteers representing 'factories' and 1 volunteer representing 'transport'. These 3 stand with the 'animals and people of the world'. They all need a stock of Carbon cards. All players on this side are releasing CO_2 into the atmosphere – **carbon emitters**. All remaining children become the 'atmosphere' - half starting as O_2 and the other half as CO_2 , with relevant molecule cards. Have a trial walk through and then run.

09 The 'atmosphere' players run between the trees and the 'factories/animals of the world' carrying the carbon dioxide and oxygen. **THEY CAN ONLY CARRY ONE MOLECULE AT A TIME!**

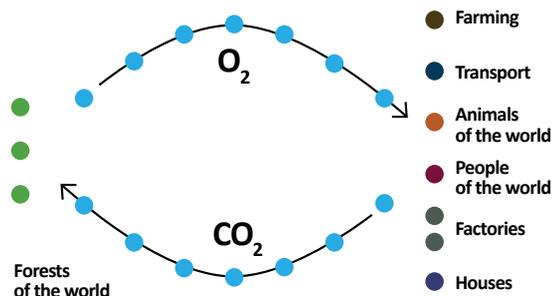
10 The game should be stopped after a few minutes to determine the level of **carbon dioxide CO_2 in the atmosphere**.

CONSEQUENCE – Trees are carbon storers - but they cannot store it all. Increased numbers of carbon emitters are causing carbon dioxide levels to start rising.

STEP 4 Deforestation

As the number of people increased in the world, forests were cut down to provide space for farming, houses, more factories and roads. When trees are cut down and the land used for a different purpose we call this **deforestation**.

Reduce your forest by felling 2 trees - removing 2 volunteers – they now become '**farms**' (burning fuel in their machines and tractors) and '**houses**' (using heat and energy/electricity from gas, coal and wood/peat by burning fossil fuels). They will need to take their carbon cards with them.



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13 Play the game again. You should see queues of atmospheric CO₂ start to develop at the forests of the world. This is a good time to freeze the game. [**HINT** If you find that queues do not form, it is usually when the 'atmosphere' players dismantle their CO₂ molecules before they reach the forest, rather than handing them to the forest to take apart!]

CONSEQUENCE - Deforestation occurs when people clear forests and use the land for other purposes. CO₂ is released when the trees are burned and fewer trees means less CO₂ is removed. CO₂ levels rise even further.

14 **STEP 5 Sustainable forests**

Discuss the importance of trees to people, naming just a small selection of things we make from trees. What will happen to CO₂ levels if we cut down more and more trees? Ask the group for their ideas about what could be done to help stop CO₂ levels from rising even higher.

15 Ask for 2 volunteers from the 'atmosphere' group. Designate an area to be a 'nursery', where 'seedlings wait to be planted in the forest – ask the volunteers to stand in this area as 'seedlings'.

16 Demonstrate the planting of seedlings in the forest by taking one of the above volunteers to the 'forests of the world' area, and providing them with a basket. Explain that as they play once more, you will cut down 'a tree' from the forests of the world, to make many different things, but you will plant a new tree 'seedling' to keep the forest the same size.

17 Start the game, and while in progress, harvest 'a tree' and replant with 'a seedling'. Continue this throughout the game. 'Trees' who are harvested can wait in the nursery ready to become the next 'seedlings'.

CONSEQUENCE - People do need to cut down trees to make many different things, but by planting new trees, a lot of CO₂ is still removed from the atmosphere – this is an example of being 'carbon lean', and of conservation management, or carbon mitigation.

18 Collect all the equipment in, and gather in a sharing circle – ask the 'animals and people of the world' what was happening at the start; the 'factories' and 'transport' team what was happening with fossil fuels being burnt; 'forests and trees of the world' what was happening during deforestation, and the 'seedlings' what was happening through sustainable management. Which choice was best for the atmosphere, animals and forests? Which choice was best in minimising the consequences for people and climate change?

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Some useful background:

- CO₂ is made from 1 atom of carbon and 2 atoms of oxygen. CO₂ is created when fossil fuels are burned.
- Trees and green plants use sunlight and the CO₂ in the atmosphere to create their own foods, through a process called photosynthesis. The carbon molecules are stored within the tree or plant and the oxygen molecules released back into the atmosphere. Forests are sometimes referred to as carbon sinks – they remove carbon from the atmosphere and store it. The forest acts as a **carbon sink** only while the carbon stock continues to increase. Eventually an upper limit is reached where losses through respiration and disturbances such as fire, storms, pests or diseases equal the carbon gain from photosynthesis.
- Forests and woodlands in the UK contain around 150 million tonnes of carbon, and every year they remove about 4 million tonnes of carbon from the atmosphere. The rate of **carbon sequestration** (soaking up) is relatively high because most of the UK's forests are young and still growing. As our forests grow older, the rate of CO₂ removal will fall.
- The Earth's climate is driven by a continuous flow of energy from the sun. Heat energy from the sun passes through the Earth's atmosphere and warms the Earth's surface. As the temperature increases, the Earth sends heat energy back into the atmosphere. Some of this heat is absorbed and reflected back to Earth by gases in the atmosphere. These gases act as a blanket, trapping in the heat and preventing it from being reflected too far from the Earth.
- CO₂ is the most significant of the gases in our atmosphere which keep the Earth warm by trapping in the heat and preventing it from being reflected too far from the Earth
- Burning fossil fuels releases the CO₂ stored millions of years ago. We use fossil fuels to run vehicles (petrol, diesel and kerosene), heat homes, businesses and power factories.
- Deforestation releases the carbon stored in trees and also results in less carbon dioxide being removed from the atmosphere.
- In Forest Stewardship Certificate certified forests, any trees that are harvested are replanted, or allowed to regenerate naturally. Forests and woodlands managed for commercial wood production through periodic harvesting generally have lower carbon stocks than stands that are not harvested, but this harvesting should not be confused with deforestation. We are in a deficit situation at present, so we need to plant even more trees to catch up, if we are also cutting them down!