Name: ....

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WithOnePlanet

> Module 1: Carbon
> Level: Years 5 to 6
> INQuIRY: Investigate
> Lesson 5: Counting the cost of carbon
> Student worksheet

Lesson 5 – Worksheets

Investigate

Lesson 5
Student worksheet
Counting the cost of carbon

Years 5 to 6

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Counting the cost of Carbon

Lesson 5a: Student worksheet

Introduction

Scientists are able to detect and analyse the carbon dioxide concentrations in many different spheres of the carbon cycle, including the atmosphere and the hydrosphere in particular.

They can do this through a variety of methods, including taking regular samples of the air at particular places over long periods of time, and taking samples of ice (called ice cores) from places like Antarctica, and analysing these for changes in the concentration of dissolved carbon dioxide in the frozen water.

Carbon dioxide concentrations are usually measured in **parts per million**, or **ppm**. Climate scientists do this by calculating the total number of air or water particles in a particular sample and then working out how many of these are carbon dioxide molecules. They then convert this number into the number of carbon dioxide molecules per million molecules of air or water.

Most climate scientists agree that if the average number of parts per million of carbon dioxide in the Earth's atmosphere reaches 350 ppm, then the impacts of climate change will be significant. Unfortunately, at this point, the Earth's atmosphere is currently registering 395.10 ppm according to the web site, Pro Oxygen (2013), where you can also check out the most up-to-date figure.

That's the bad news. But the good news is that the Earth's carbon dioxide concentration is not fixed. It can both increase and decrease depending on the actions that are taken by individuals, communities, countries and all global citizens. You, your family, your school and your local community can take positive action to decrease the amount of carbon dioxide present in our atmosphere.

In this activity, you will be observing and analysing a number of sets of data, collected over time by climate scientists, and showing some interesting changes in carbon dioxide concentrations.

Activity 1: Recent carbon dioxide concentrations

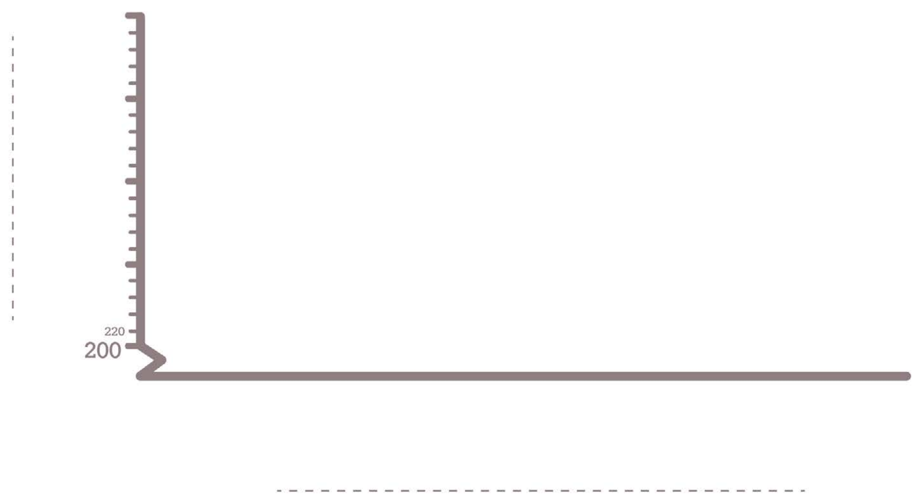
When referring to carbon dioxide concentrations, the term, *recent*, really means *since records began*. Recent refers to any data that humans have recorded for themselves at a particular place at regular intervals.

The following data set showing carbon dioxide concentrations from 1750 to 1990 is an example of *recent* data.

Year	Carbon dioxide concentration
1750	282 ppm
1800	283 ppm
1850	290 ppm
1900	297 ppm
1950	312 ppm
1980	335 ppm
1990	350 ppm

Complete the graph below to show the data from the table above. Label the horizontal axis 'Year' and the vertical axis 'Carbon dioxide concentration'. Give the graph an appropriate title.

Graph title: ____



Answer the following questions about this data set in the spaces provided.

Q1a: What happened to the carbon dioxide concentration between 1750 and 1990?

Q1b: Between which years did the carbon dioxide concentration increase the most?

Q2a: Based on the data provided, what would you predict that the carbon dioxide in the year 2000 might have been? Give a reason for your answer.

In fact, the annual carbon dioxide concentration for the year 2000, recorded at 369.52 ppm, can be found at Earth System Research Laboratory – Global Monitoring Division (2013).

Q2b. Is this the same, or higher or lower than your prediction in part a. above?

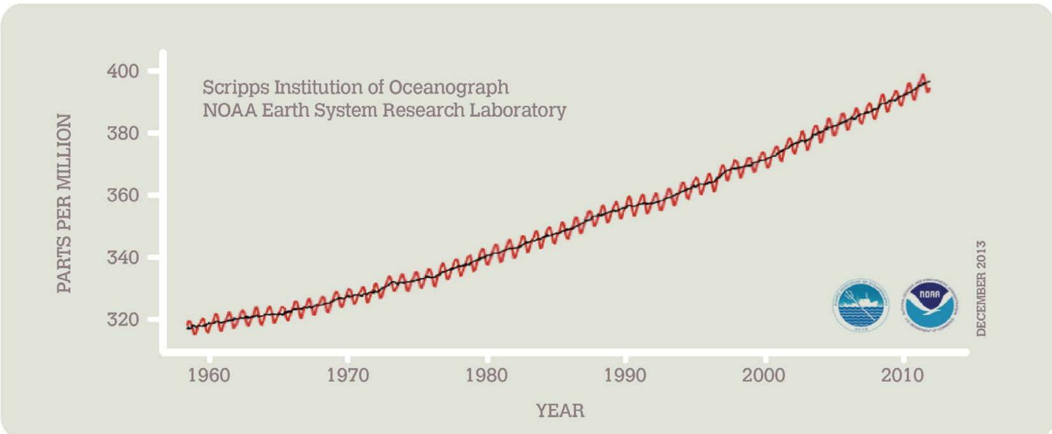
Q2c. What might be some reasons for the difference between your predicted carbon dioxide concentration for the year 2000 and the actual carbon dioxide concentration?

Activity 2: Carbon dioxide concentrations at Mauna Loa, Hawaii

In March 1958, at a scientific laboratory in Mauna Loa, Hawaii, a scientist named C. David Keeling first began to record direct measurements of carbon dioxide concentration in the atmosphere. This laboratory, a facility of the National Oceanic and Atmospheric Administration, has recorded this same data ever since.

You can see the now famous summary of this data in the graph below. The red line shows the actual data and the black line shows the seasonally corrected data.

Graph: Atmospheric CO_2 at Mauna Loa Observatory, Hawaii



Sources:

ESRL Global Monitoring Division 2013, *Atmospheric CO_2 at Mauna Loa Observatory*, viewed 29 December 2013, <http://www.esrl.noaa.gov/gmd/ccgg/trends/index.html>.

You will notice that the red line moves up and down in a regular pattern. Mauna Loa, Hawaii measures the atmospheric carbon dioxide concentration of the northern hemisphere. In the northern hemisphere, most trees are deciduous. That is, they lose their leaves every autumn and grow new ones every spring.

Q1a: When a tree loses its leaves, they drop to the ground where they decompose. Some of the carbon in the leaves moves into the soil. Where does the remaining carbon in the leaves go?

Q1b. If most of the trees in the northern hemisphere lost their leaves at approximately the same time, how might this affect the measurement of atmospheric carbon dioxide concentrations at Mauna Loa?

Therefore, what climate scientists have done is take an **average** of the carbon dioxide concentrations at Mauna Loa each year. This means that any increases in CO_2 due to leaf fall, and decreases in CO_2 due to leaf regrowth are taken into account.

Q2a. According to the data collected at Mauna Loa, what has happened to the carbon dioxide concentration between 1958 and 2013?

Q2b. Based on the Mauna Loa graph above, when do you predict that the carbon dioxide concentration will reach 400 ppm? Give a reason for your answer.

Activity 3: Carbon dioxide concentrations over geologic time

When scientists talk about geologic time, they are referring to the distant past. Geologic time refers to time stretching back to when the Earth first formed and all the time between then and now. It is called 'geologic' because the information about such distant times can only be found in samples of the Earth. Scientists who study the Earth are called geologists and the study of the Earth is called geology. The time that humans have lived on Earth is a very tiny fraction of geologic time.

If climate scientists want to look at how carbon dioxide concentrations have changed over geologic time, they cannot rely on data collected by humans themselves. They need to look at rocks and ice. Scientists are able to look at 'fossilised' air trapped in ice cores taken from deep down in Antarctic ice. This 'fossilised' air takes the form of tiny air bubbles that have been trapped in the ice ever since the ice was formed. Therefore, the deeper you go down into the ice, the earlier in geologic time the bubbles were trapped.

Amazingly, information from ice has been dated up to 850,000 years ago!

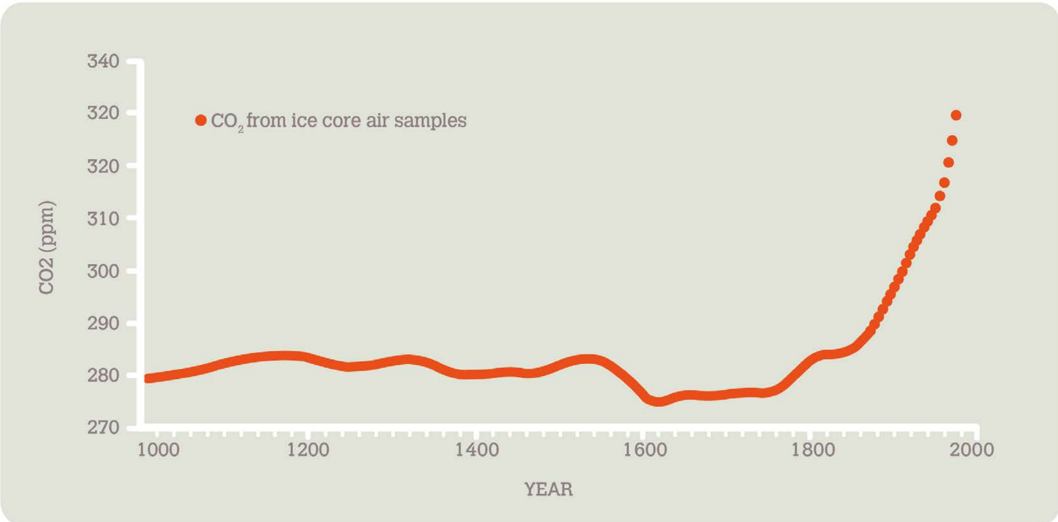
In a nutshell – About how ice cores are made

https://www.youtube.com/watch?v=_zszUK7i7K0&list=PL4twzw4BAfFED-XioKJyPDnAnblwwPgz-

Source:
Climate Science in a Nutshell #3: *Evidence of a Warming Planet* viewed 20 October 2014 <https://www.youtube.com/watch?v=_zszUK7i7K0&list=PL4twzw4BAfFED-XioKJyPDnAnblwwPgz->.

Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) has put together results from ice core data over the last 1000 years, as shown in the graph below.

Graph: Ice core data over the last 1000 years



Q1a: Based on the ice core graph above, what has happened to the carbon dioxide concentration between 1000 AD and 2000 AD?

Q1b: What happened around 1800 AD that caused the graph to start accelerating upwards?

Q1c: What could have caused the minor changes to ice core carbon dioxide concentrations before 1800 AD?

Sources:

Atmosphere, Australia State of the Environment Report 2001 (Theme Report): *Climate variability and change (Enhanced Greenhouse Effect 2001), Carbon dioxide concentration from ice core and air samples since AD 1000*, viewed 29 December 2013, <http://www.environment.gov.au/node/21494>.

Pro Oxygen 2013, viewed 29 December 2013, *<http://co2now.org>. Earth System Research Laboratory – Global Monitoring Division 2013, Trends in Atmospheric Carbon Dioxide*, viewed 29 December 2013, *<http://www.esrl.noaa.gov/gmd/ccgg/trends>*.

Calculate your own carbon

Lesson 5b: Student worksheet

Introduction

What is an ecological footprint?

An ecological footprint, or ecofootprint, is one way of measuring how much carbon dioxide your actions and activities release into the atmosphere. This is shown in terms of the amount of land you need to produce all the energy and resources you need for everything that you do.

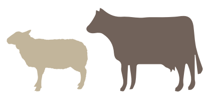
The infographic below summarises this for you.

What is an ecological footprint

It is a measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes, and to absorb the waste it generate. The Ecological Footprint is usually measured in global hectares (gha).

Carbon

Represents the amount of forest land that could sequester CO_2 emissions from the burning of fossil fuels, excluding the fraction absorbed by the oceans which leads to acidification.

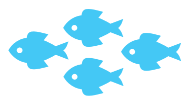


Grazing land

Represents the amount of grazing land used to raise livestock for meat, dairy, hide and wool products.

Cropland

Represents the amount of cropland used to grow crops for food and fibre for human consumption as well as for anumal feed, oil crops and rubber.



Fishing grounds

Calculated from the estimated primary production required to support the fish and seafood caught, based on catch data for marine and freshwater species.

Forest

Represents the amount of forest required to supply timber products, pulp and fuel wood.

Built-up land

Represents the amount of land covered by human infrastructure, including transportation, housing industrial structures and reservoirs for hydropower.

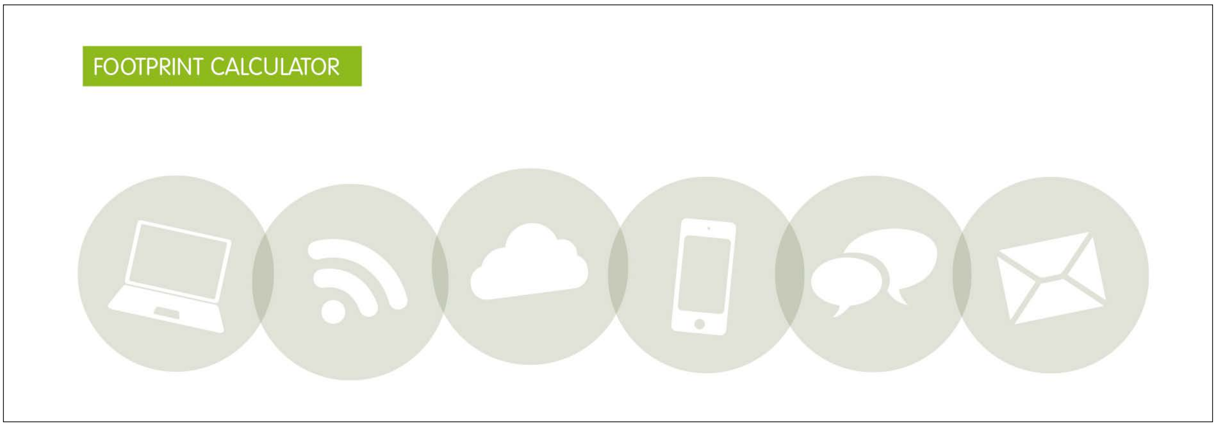
Source:
WithOnePlanet, *ecological footprint* infographic 2015.

How can I calculate my ecofootprint?

The simplest way to calculate your ecofootprint is to use a specially designed online calculator. All you need to do is answer some questions about what products (e.g. a car, a clothes dryer) you use and how often you use them, as well as what types of energy you use (e.g. home gas and electricity use) and how much you use.

As well as looking at all the energy and resources you use, the ecofootprint calculator will take into account the environmentally friendly choices you make. For example, whether or not you use public transport rather than a car, whether your house has solar panels on it, etc.

A simple way of summarising what a ecofootprint calculator may includes for different technology devices and the internet is shown below.



What does my ecofootprint tell me?

Once you have used the online calculator to input all of the necessary information, the calculator will convert this information into an equivalent **amount of land** needed to supply you with everything you need to live your current lifestyle.

This amount of land is given in **global hectares**.

A global hectare refers to one hectare (approximately soccer field size) of land in good condition (for growing plants and grazing animals for example).

Your ecofootprint can also be converted into the **number of Earths** that you would need if ALL the individuals on the planet lived like you. The graphic below explains this idea.

Sources:
WithOnePlanet, *footprint calculator* infographic 2015.
WithOnePlanet, *my ecological footprint* infographic 2015.

How can I use my ecofootprint?

You can use your ecofootprint in two main ways.

1. To develop a personal plan for a more sustainable lifestyle.

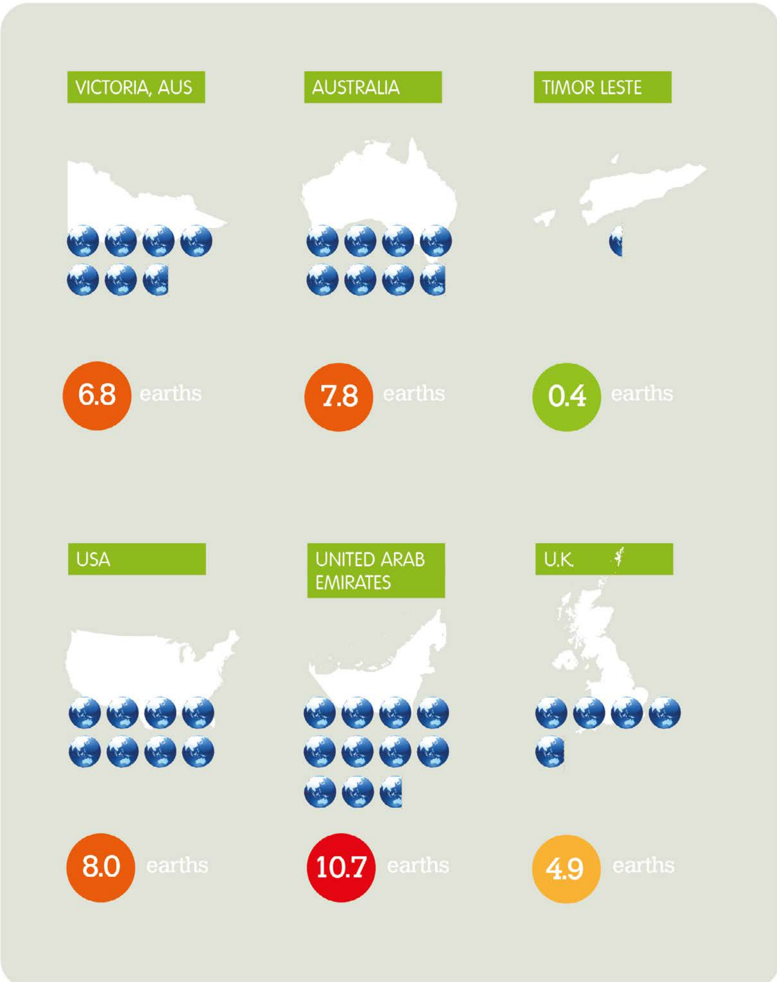
You can analyse the different parts of your ecological footprint and identify the areas where you could take positive action to reduce it. You can then brainstorm some ways that you could reduce the number of global hectares you require to sustain your lifestyle. Once you have the strategies in mind, you will need to make a plan for how to put them into action. It is always a good idea to check how you are going regularly and update your plan if you need to.

2. To compare your footprint to the footprints of other people around the world.

You can also compare your own ecofootprint with that of other people (such as classmates), or even compare your ecofootprint with the average ecofootprint of a person in a particular region (such as the state of Victoria), a particular country (such as Australia or Timor Leste), or the average global citizen.

In the diagram below, you can see the average number of Earths that people in 5 different countries/continents require to sustain their particular lifestyle (but not an equal lifestyle).

The drawing below shows how many planets are necessary to sustain the lifestyle of the different continents



Source:
WithOnePlanet, *Earths per countries/continents* infographic 2015.

Calculate your ecofootprint

EPA Victoria's personal Ecological Footprint calculator (EPA Victoria 2013) is a good one to use, as it is specifically for Australians. You can find it here: <http://www.epa.vic.gov.au/ecologicalfootprint/globalfootprint/index.asp>

Try completing the calculator using the 'basic' information version first. Once you have completed it and answered the questions below, you may like to have a go at the 'detailed' version.

What is your personal ecofootprint?

In global hectares: ______________________________

In Earths: ______________________________

Analyse your ecofootprint

Q1: What are the **three** main areas (e.g. consumption of meat) of your lifestyle that contribute most to your ecological footprint?

Area 1: ______________________________

Area 2: ______________________________

Area 3: ______________________________

Q2: Choose one of the three areas listed in Q1 above to complete the following table.

Area of choice:	
What specific action will I take to actively reduce my ecofootprint in this area?	I will ...
When will I start to make this change? (continue on next page)	I will start ...

Area of choice: (contined from previous page)	
How often does this action occur? (e.g. daily, weekly, etc.)	I will do this every ...
How regularly will I check that this change is occurring?	I will monitor this every ...
How will I know that I have succeeded in making this change?	I know I have succeeded when ...
What specific action will I take if, at first, I am not able to successfully make this change?	I will ...

Q3a: The table below shows the average ecological footprints for a number of different populations.

Table: The ecological footprints per capita of various countries and regions

Geographical location	Average number of global hectares required to sustain a person in their current lifestyle
Victoria	6.8[1]
Australia	7.8[1]
Timor Leste	0.4[2]
South-east Asia (excluding Australia)	<0.8[3]
U.S.A.	8.00[2]
United Arab Emirates	10.7[2]
U.K.	4.9[2]
New Zealand	4.9[2]
The world	2.71

Sources:

[1]EPA Victoria 2013, *Australia's and Victoria's Ecological Footprint*, viewed 19 Dec 2013, <http://www.epa.vic.gov.au/ecologicalfootprint/ausfootprint/default.asp>.
[2]Global Footprint network 2010, *Ecological footprint Atlas 2010*, viewed 19 Dec 2013, <http://www.footprintnetwork.org/en/index.php/GFN/page/ecological_footprint_atlas_2010>.
[3]Global Footprint Network 2011, *World Map: Global Distribution of the Ecological Footprint*, viewed 19 Dec 2013, <http://www.bfs.admin.ch/bfs/portal/en/index/themen/21/03/01.html>.

In terms of the number of global hectares required, is your ecofootprint **higher, lower** or **the same** as the average person in …

Victoria? ______________________________

Australia? ______________________________

South-east Asia? ______________________________

The world? ______________________________

Q3b: Where you have a LARGER ecofootprint than other populations (in Q3a above), suggest some reasons for this.

Q3c: Where you have a SMALLER ecofootprint than other populations (in Q3a above), suggest some reasons for this.

Q3d: If the total amount of global hectares available were spread evenly between everyone living on the planet today, each person would have **2.1 hectares (EPA Victoria 2013)** to sustain their lifestyle. This is far less than you currently have available for your lifestyle.

What are some of the **major actions** you would need to take to reduce your ecofootprint to this level?

Q4a: Do you think everyone on the planet should use the same number of global hectares to sustain their lifestyles? Why/why not?

Q4b: If we decided to help our neighbours in the Asia-Pacific to increase their ecofootprints to the 2.1 average, what are some of the actions we could take?

Source:

EPA Victoria 2013, *Australia's Footprint*, viewed 30 December 2013, <http://www.epa.vic.gov.au/ecologicalfootprint/ausFootprint/>.