

The Science Behind – “Planet Earth Needs Our Help”



***A magical new children’s book about Climate Change
Annie and Tilly meet an unhappy fairy in their garden; they explore Planet Earth with her in
their quest to understand the causes and effects of climate change.***





Gardens...

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...are mini-ecosystems. Plants (flowers, fruit and vegetables) grow in soil. They are eaten by insects, slugs, and snails; these are eaten, in turn, by birds and hedgehogs. When plants and animals die, they are consumed by more insects, worms and smaller organisms, creating humus – the organic “fertilizer” in soil. Bees and insects help to spread pollen, fertilizing plants, to enable them to grow. All species are interdependent – they need each other to survive. Using pesticides or introducing alien species can stop the whole ecosystem from working properly.

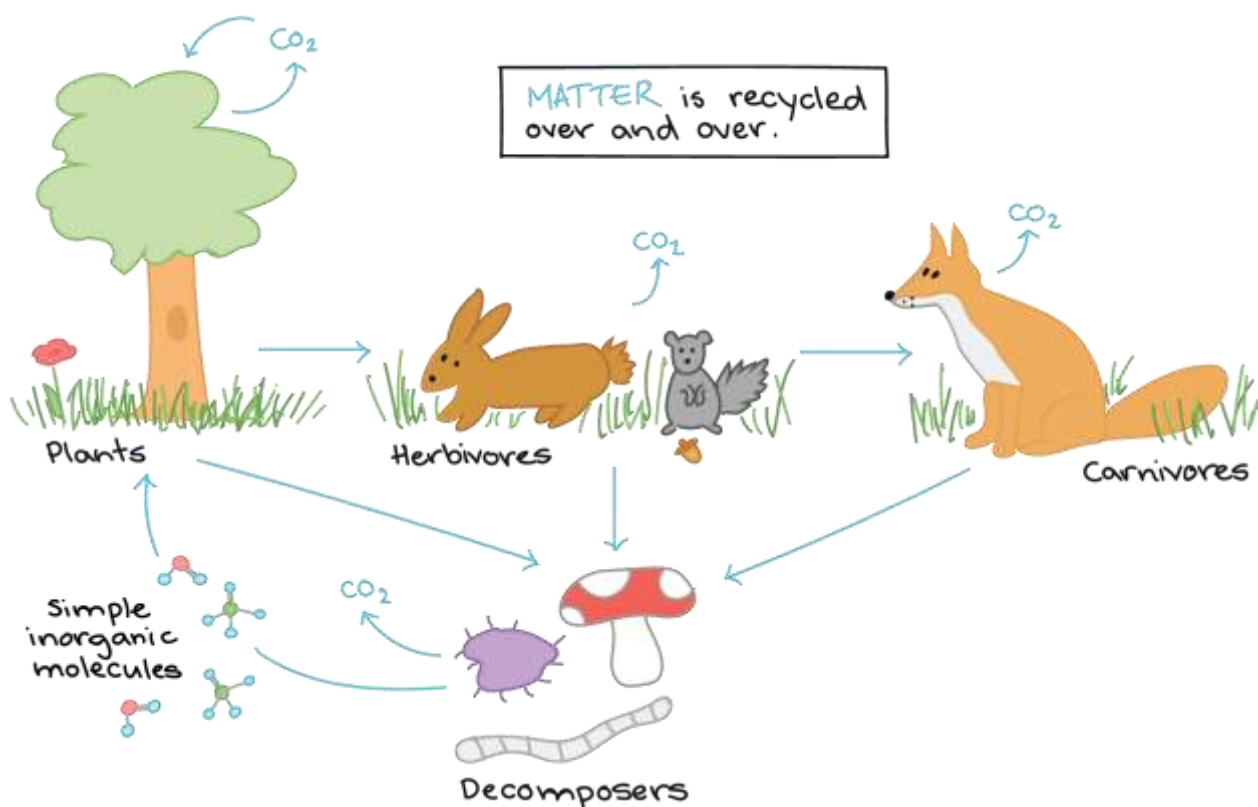


Image source: <https://www.khanacademy.org/science/biology/ecology/intro-to-ecosystems/a/what-is-an-ecosystem> based on similar image by J. A. Nilsson



Ecosystems...

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...are the basis of all life on earth. Water, air and soil nutrients are used to support plants, animals and decomposers, (organisms that break down dead plant and animal matter). The key chemicals of life – carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium - are naturally recycled. If the ecological balance of these natural cycles is disrupted, (eg. pollution adds too much carbon to the environment) there are problems for wildlife and food. If the weather is too hot, too wet, too dry – or if people kill key species – this can damage ecosystems, and ultimately all life: humans too!

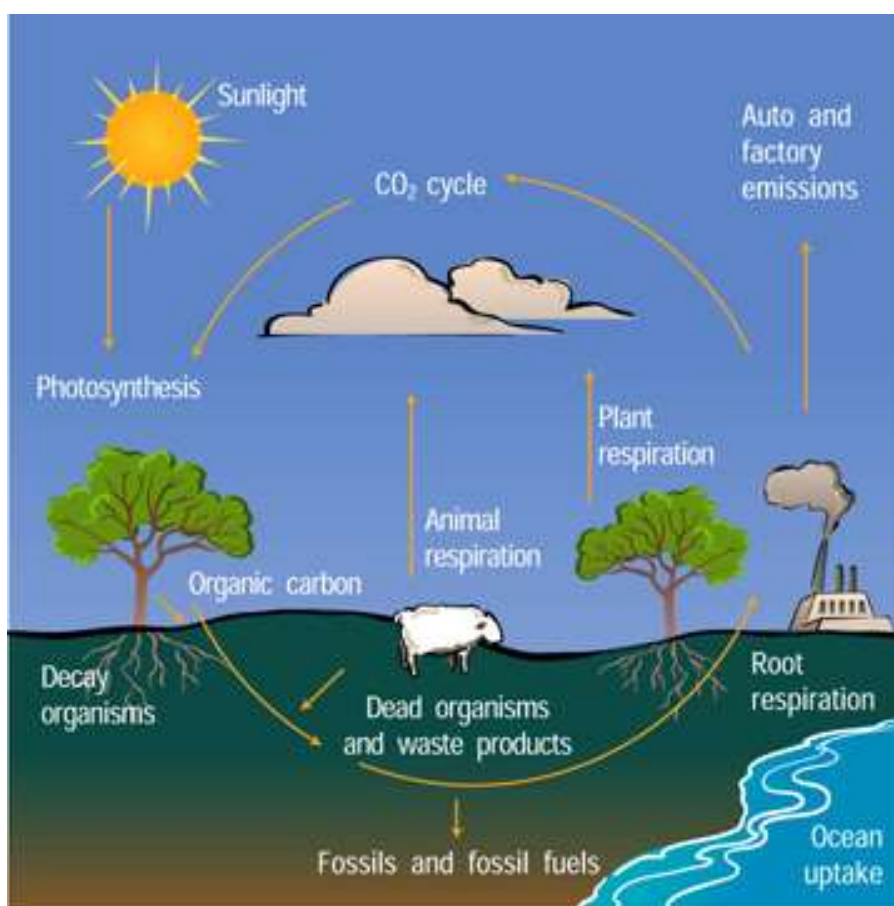


Image source: <https://eo.ucar.edu/kids/green/cycles6.htm>

As the diagram shows, fossil fuels (coal, oil and natural gas) are carbon, released from dead plants, that has been stored in the rocks. By burning these fuels, we return the carbon dioxide (CO₂) to the air, adding to the blanket of gases which traps heat in the air and oceans. This is the main cause of global warming



Planet Earth Getting Hotter

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Planet Earth is perfect for life. It lies in the “Goldilocks Zone” – just the right distance from the Sun. It is warm enough for water to exist as ice or as a gas. Other planets are too hot for life (Venus) or too cold (Mars). So Earth has oceans, and an envelope of gases (the atmosphere) supporting life. Heating of oceans evaporates water vapour; winds (heat currents) in the air move this around, enabling rain to fall far from the oceans. If we heat up the Earth, more water vapour is evaporated, winds are stronger, and land becomes warmer. This causes more, heavier storms and floods, more droughts, and more heatwaves.



Greenhouse Effect

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Earth gets its heat and energy from sunlight. This passes through the transparent atmosphere; hitting land and oceans, sunlight is turned to heat at the Earth's surface. This heat creates ocean currents and winds. As more heat falls in the tropics, this has to be spread towards the poles, carrying moisture with it.

The atmosphere contains gases like carbon dioxide and methane, which are the products of ecosystems. These gases act as an invisible blanket, keeping the heat in (like glass in a greenhouse). If people add more of these gases to the atmosphere, more heat is retained, and the climate gets hotter.

The main greenhouse gases are water vapour, carbon dioxide, methane, ozone, nitrogen oxides and fluorine compounds (including CFC's). Carbon dioxide comes mainly from burning fossil fuels for heating, cooking, transport (mainly aeroplanes, large ships and motor vehicles) and burning of natural forests. Methane comes from grazing animals and drying out of marshland and permafrost. (There are 1,500bn tonnes of carbon stored in permafrost, almost double all the carbon in the atmosphere). Nitrogen oxides are also released from burning fossil fuels, and from agricultural fertilizers. CFC's are used in fridges and spray cans, for example.



Mass Extinctions and climate

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It is natural for the climate to change slowly. But, if it changes too fast, most plants and animals cannot adapt and survive. Sudden changes are catastrophic.

There have been at least 5 periods when nearly all plant and animal species on Earth have been wiped out by mass extinctions. This has usually been because huge volcanic eruptions, asteroid strikes, etc. push more dust into the atmosphere, increasing the Greenhouse Effect and causing the climate to get hotter. The last extinction, 66 million years ago, wiped out 75% of all species, including most of the dinosaurs.

The “Living Planet Index 2016” (produced by WWF) found that populations of land animals have declined by 38 per cent overall since 1970, with an average annual decline of 1.1 per cent. Populations of freshwater species have declined overall by 81 per cent between 1970 and 2012, with an average annual decline of 3.9 per cent. For marine animals there has been a 36 per cent overall decline between 1970 and 2012, with an average annual decline of 1 per cent. Overall, around 1 million animal and plant species are now threatened with extinction, many within decades, more than ever before in human history. Virtually all of these reductions in wildlife are due to human activity – land clearing, pollution, hunting and climate heating.



Natural climate change

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Climate changes naturally; only 8000 years ago, much of North America and Europe was covered with ice. Technically, we are still in a warm period of this Ice Age, and climate should be starting to get colder again.

Natural climate change is caused by variations in the amount of solar energy reaching Earth, by gases and dust created by volcanic events, and by continental drift – changing the position of land masses, which alters the ocean shapes and the position of ocean currents.

There have been geological periods much hotter or colder than today – they supported very different ecosystems of plants and animals.



Fossil Fuels and pollution

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The fact that climate has got 1⁰C warmer in the last two hundred years is almost entirely due to human causes – air pollution, deforestation, desertification – reversing the natural cooling trend of Ice Age climate.

In the past 200 years, since the Industrial Revolution, we have started to burn carbon stored in the rocks of the Earth's surface during previous, more CO₂-rich geological periods. Burning coal, oil and gas (fossil fuels) releases carbon dioxide and sulphur gases – the main causes of climate change. CO₂ levels have increased by over 42% since 1750.

The amount of the gas going into the atmosphere between 2015 and 2019 grew by 20% compared with the previous five years. As a result, while global temperatures have risen by 1.1 degrees C since 1850, they have gone up by 0.2C between 2011 and 2015. At this rate, temperatures will rise as much by 2030 as they did in the previous 160 years! As climate warms, ice caps melt, making the earth's surface darker and less reflective of solar energy.

Increased fires with warming reduce forest cover, and reduce nature's ability to re-absorb CO₂. The result is that the rate of climate warming can easily accelerate, giving us less time to reverse global warming.



People and Environment

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Our modern industries and cities have upset the natural balance of climate and ecology. Farming creates damaging greenhouse gases - methane from animals, and nitrogen oxides from fertilizers. More farm animals means more methane. Deforestation – mainly for farming – kills species, reduces the land’s ability to re-absorb carbon dioxide, and reduces rainfall, leading to desertification. The result is likely to be major reductions in food growing capacity in the near future due to loss of soil, drought, wind erosion, falling water tables. Farm chemicals cause water and air pollution, killing fish, wildlife and vital pollinators.

Urban areas have more than doubled since 1992. Plastic pollution has increased tenfold since 1980, 300-400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped annually into the world’s waters, and fertilizers entering coastal ecosystems have produced more than 400 ocean ‘dead zones’. Humans are now the biggest cause of environmental changes.



Sea level rise and ocean impacts

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Most sunlight falls on oceans, where it warms the upper waters. With global warming, oceans get hotter and expand. Combined with the melting of ice sheets, this is causing sea level to rise: leading to coastal flooding and increased erosion. Low lying areas such as Bangladesh are already suffering – and many of the world’s major cities are threatened unless the warming can be stopped. London already has the Thames flood barrier to protect it – but rising sea levels could render it useless.

On average, 653bn tonnes of ice melted in Greenland, Antarctica and mountain glaciers every year from 2006-2016, equivalent to 500 Olympic swimming pools every minute. The result could be a rise in sea levels of 5.4 metres by 2300, if global carbon emissions are not cut. Combined with increased frequency and intensity of storms, coastal and river flooding poses and increasing threat to many of the large cities in the world.



Weather and climate change

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Floods, droughts and storms are already becoming more frequent and more severe. In 2018, in the USA, the cost of storm and flood damage, and of droughts and resulting fires was equal to over 2% of GDP, (ie. reducing the benefits of economic growth). The worst effects of global warming affect the poorest nations and people. Crop failures caused by droughts and water shortages are a major factor behind wars in the Middle East and Africa. War and climate poverty is increasing the risks of famine, disease epidemics (Ebola) and driving the refugee crises in the Mediterranean and Mexico.

Coastal flood damage is expected to increase between 100 and 1000 times by 2100, unless major adaptation efforts are made. 1.8 billion people are likely to be directly affected by sea level rise on low-lying coasts and melting glaciers in high mountain regions in 2050.



The impact on people

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The natural cycles of ecosystems and the planet are being replaced by new “positive feedback loops”. More heat warms the tundra across Russia and Canada – this melts the permafrost (frozen sub-soil) releasing methane, which makes warming even worse. Melting of ice sheets makes the Earth’s surface darker, it absorbs more heat and reflects less, adding to global heating. We could reach a “tipping point”, where warming is impossible to stop. Heat, droughts, storms and crop failures could destroy the basis of our civilizations.

Three-quarters of the land-based environment and about 66% of the marine environment have been significantly altered by human actions. Land degradation has reduced the productivity of 23% of the global land surface, while 33% of marine fish stocks are being harvested at unsustainable levels. These statistics mean that serious problems are being created for our ability to feed the growing world population.



Planet Ocean

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Oceans cover more than 66% of Earth's surface – so most sunlight falls on water. Heating the ocean surface results in evaporation of water vapour; when carried by winds over land, this is the source of all the rain and snow which makes life possible on land. Ocean currents carry heat towards the poles, and enable life to extend into higher latitudes. Europe could become both hotter and wetter.

Ocean heating (and acidity, as oceans dissolve more greenhouse gases) also destroys coral reefs and disrupts ecosystems, threatening global fisheries. Fishing provides a sixth of the world's animal protein, and supports millions of jobs.

More than 90% of the excess heat caused by climate change ends up in the waters of our oceans. This causes huge problems for marine life – in particular, coral reefs are disappearing at an alarming rate. There is much evidence that the limits of the oceans capacity to absorb excess heat is being reached – meaning that the atmosphere will begin to heat up even faster than it has in the past. Climate problems could get much worse very quickly.



Where are we now?

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Despite many political promises, climate change is still getting worse. In 2018, carbon emissions rose by 2%. The 1.5% maximum increase in CO₂ target from the Paris Conference cannot be met with world-wide change – the UK Government's 2050 date for achieving Zero Carbon Emissions may even be too late. Others suggest 2030 – ie. we have 12 years to act.

The carbon crisis is directly inter-linked with other crises – species extinction; degradation of natural habitats, forest, soil and water resources; plastics, waste and pollution problems; and human health.



The need for political action

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It is clear that the cost of not acting on climate change will be greater than the cost of making rapid changes in how much energy we use, and what sources we use. Many of these changes needs to come from governments, to act on the causes, not just the symptoms of climate change.

In UK, we need to stop subsidies to fossil fuels, and to encourage a rapid shift to clean, renewable energy sources. We need to switch to electric vehicles, and limit use of planes. Above all, we need to invest into research and development in new technologies, and new industries to produce these quickly and affordably.



Practical, everyday actions we can take

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We can take simple actions ourselves at home (see the leaflet from local Friends of the Earth); saving energy, using renewables, wasting less food and materials, recycling and composting, creating wildlife gardens.

“Planet Earth Needs Our Help” provides an easily understood guide to Climate Change. With this knowledge, we can make relevant and collaborative lifestyle changes – both to reduce their impact upon climate, and to deal with the consequences which are already upon us.

We need to tell governments what they must do and make informed choices when voting and responding to decisions by politicians.



**Hope for the future: education,
research, innovation**

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We all need to find out more about Climate Change and what we can do about it. But it is future generations who will suffer the consequences if we don't act NOW!

The “Planet Earth Needs Our Help” book and resource pack is specifically aimed at helping children (and families). We still have a few years to act, to avoid catastrophic climate change: we need new ideas, good evidence, open minds, rapid political action and a positive attitude.

Please join us in helping Planet Earth!