

The well-being and functioning of our planet depends on carbon and how it cycles through the Earth's systems. There has been a natural balance between how carbon is released and stored in these cycles, but human interference has caused this balance to be disturbed. To better understand this problem, you need to know about sources and sinks.

Sources

- Processes that release carbon dioxide (CO₂) to the atmosphere are called carbon "sources".
- A source emits more than it absorbs.
- Natural sources include volcanoes, fires, decomposition, respiration, digestion and, under certain conditions, oceans and freshwater bodies. (The latter can release large amounts of dissolved CO₂ when waters warm up or are disturbed by storms or tremors.)

Sinks

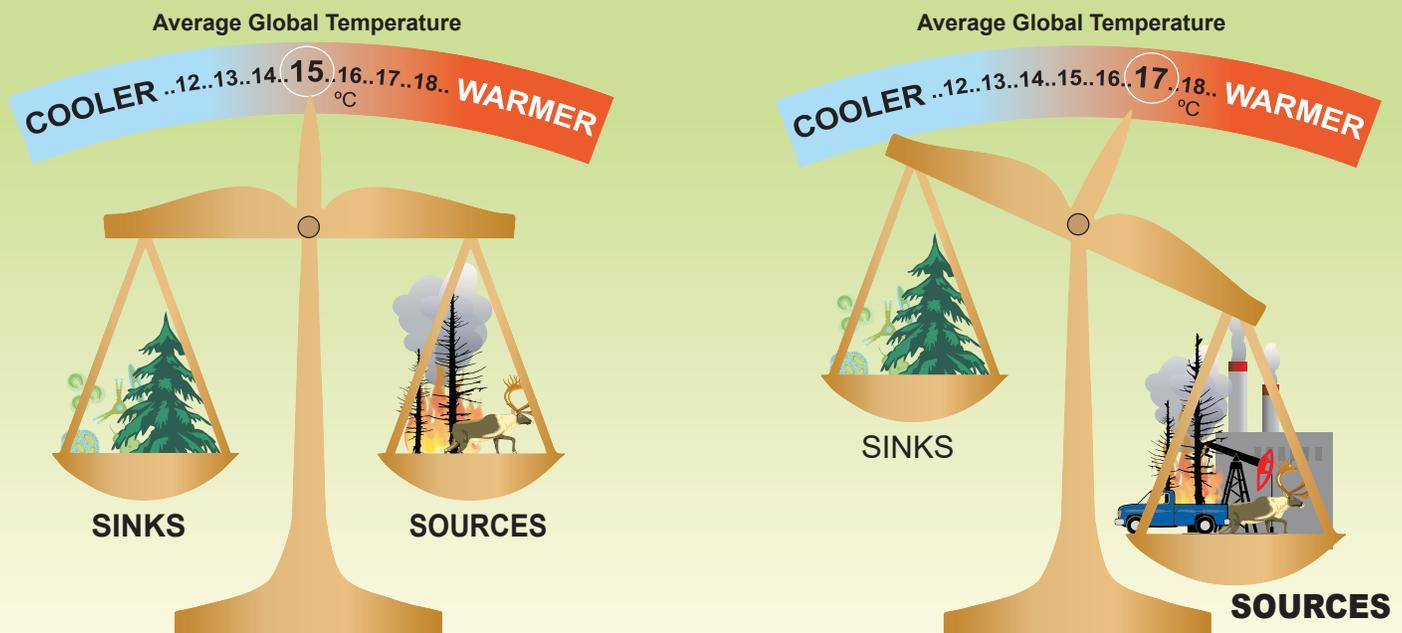
- Processes that absorb it are called carbon "sinks".
- A sink absorbs more carbon than it gives off
- Forests, soil, oceans, the atmosphere, carbonate rocks and fossil fuels are important stores of carbon.
- Natural sinks for atmospheric CO₂ include photosynthesis, forests, oceans and freshwater bodies, fossil fuels and carbonate rocks.

Balance

- Carbon is constantly recycled between these different "sinks" and "sources."
- The amount of carbon in the atmosphere depends on the balance that exists between the sinks and sources.
- This system of sinks and sources operates all over the planet and is known as the carbon cycle.
- Before the Industrial Revolution, the amount of carbon moving between trees, soil, oceans and the atmosphere was relatively balanced.

The well-being and functioning of our planet depends on carbon.

Sources & Sinks - Greenhouse Gases in Balance



Important Sinks

Forests

- Land plants account for about 25% of the carbon extracted from the atmosphere.
- Carbon is absorbed through photosynthesis and then stored in forest biomass (trunks, branches, roots and leaves), dead organic matter (litter and dead wood) and in soils
- The net balance determines whether a forest is a source or sink
- For the past century, Canada's managed forests have been a significant carbon sink, steadily removing carbon from the atmosphere.
- In recent decades, however, Canada's forests have often become carbon sources, releasing more carbon into the atmosphere than they are accumulating in any given year.
 - Deforestation is reducing the size of this sink, allowing more carbon dioxide to remain in the atmosphere.
 - Carbon is released when trees burn or when they decay as a result of a disturbance.
 - The annual total area burned by wild fires has increased substantially.
 - Unprecedented insect outbreaks have occurred due to the warming trends

Lakes, Seas and Oceans

- Approximately 25% of atmospheric carbon dioxide is absorbed into certain areas of the oceans. Colder water can absorb higher amounts of CO₂.
- Oceans are absorbing increasing amounts of CO₂,
 - Areas of the ocean where the concentration of CO₂ is higher in the water than in atmosphere above, CO₂ is released to the atmosphere.

- Increased CO₂ increases ocean acidity which is harmful to many marine species, especially calcifying organisms including corals, shellfish and phytoplankton
- Aquatic plants in lakes, seas and oceans use carbon dioxide dissolved in water for photosynthesis.

Underground

- Carbon is stored in soil as organic carbon from the decomposition of living organisms
- When marine organisms die, their remains may sink, forming sediment on the ocean floor and under great pressure over geologic time, turn into limestone, which is the largest carbon reservoir on Earth.
- Remains of ancient decomposed plants and animals are buried under layers, subjected to great pressure over thousands of years, to form fossil fuels such as oil, coal, and natural gas.

Artificial Carbon Sinks - Sequestration

- Man-made carbon sinks can be created or use existing underground formations, or even the oceans, to store CO₂.
- The main artificial sinks are landfills and carbon capture and storage processes.
- Research currently going on:
 - Capturing and CO₂ and storing it by injection into the ocean floor or underground empty rock formations that used to hold fossil fuels, like depleted oil reservoirs.
 - Replicating the natural process of mineral carbonation that uses CO₂ to transform natural minerals into carbonate rocks, like limestone.
 - Stimulating the growth of microorganisms in the southern oceans by fertilizing the surface with iron.

Land plants account for about 25% of the carbon extracted from the atmosphere.

Another 25% is absorbed by oceans and lakes.



The Canadian Encyclopedia

Important Sources

Natural Sources

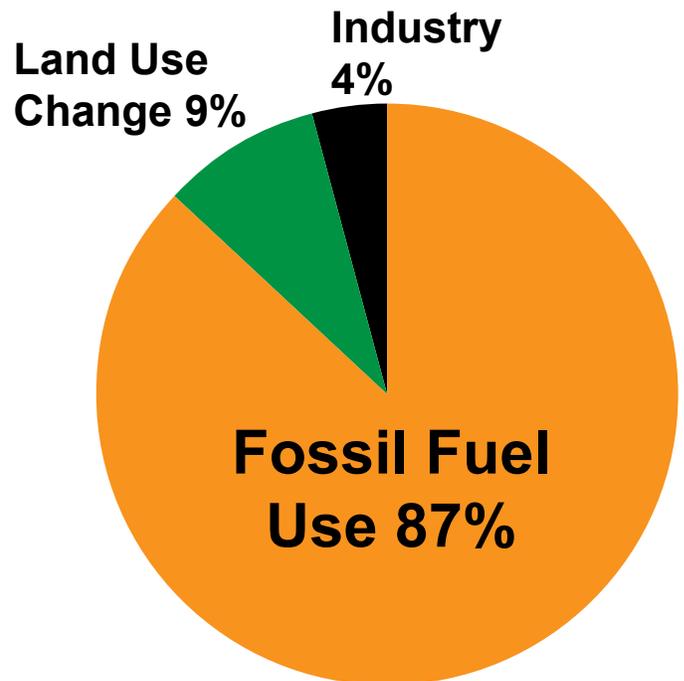
- Respiration of living things - the process used to break down sugar to produce energy and has CO₂ as a byproduct
- Decomposition - Many organisms that live in the Earth's soil use respiration to produce energy. Amongst them are decomposers who break down dead organic material. Both of these processes release carbon dioxide as a byproduct.
- Ocean atmosphere exchange - The oceans contain dissolved carbon dioxide, which is released into the air at the sea surface but they also absorb it.
- Volcanic activity - A minor amount carbon dioxide is released by volcanic eruptions

Artificial Sources - Throwing Off the Balance

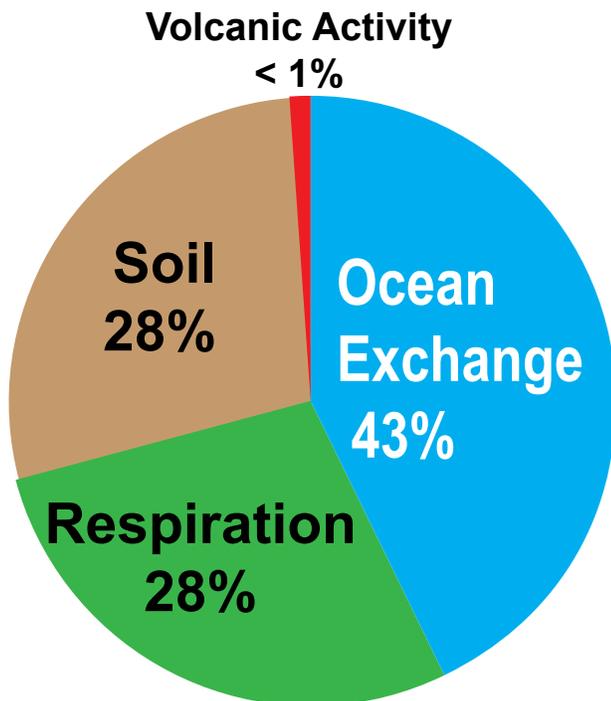
Human activities are interfering with natural carbon sinks, turning them into carbon sources;

- Extraction, processing and use of oil, gas and coal is the greatest contributors to the increased carbon emissions.
 - Since the beginning of the Industrial Revolution, when people first started burning fossil fuels, carbon dioxide concentrations in the atmosphere have risen 39 percent - the highest concentration in two million years.

HUMAN SOURCES OF CARBON DIOXIDE



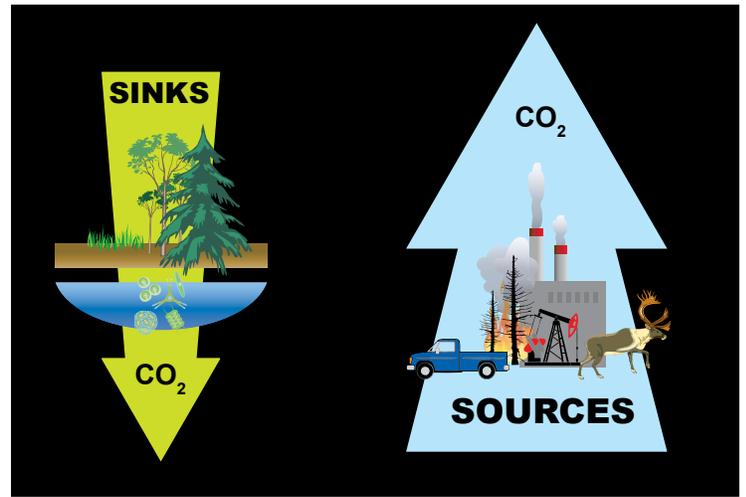
NATURAL SOURCES OF CARBON DIOXIDE



- Clearing forests for agriculture and logging can result in;
 - the loss of a dense growth of plants that had stored carbon in wood, stems, and leaves—biomass.
 - elimination plants that would otherwise take carbon out of the atmosphere as they grow.
 - replacement of the dense growth with crops or pasture, which store less carbon.
 - exposure of soil that then releases carbon from decayed plant matter into the atmosphere.
 - (Draining/disturbing wetlands, peat bogs and grasslands also end in additional CO₂ release.)
- Industrial Activity
 - Cement production produces the most carbon dioxide of all industrial processes when limestone is chemically transformed by heating it to very high temperatures.
 - Steel production requires iron to be melted and refined to lower its carbon content which uses oxygen to combine with the carbon resulting in the release of large amounts of carbon dioxide.
 - The industrial production of ammonia and hydrogen most often use natural gas or other fossil fuels as a starting base, creating carbon dioxide in the process. Products like plastics, solvents, and lubricants are created using petroleum. These products evaporate, dissolve, or wear out over time releasing even more carbon dioxide.

Time & Balance

- The cycling of carbon between the atmosphere, plants and animals can take place quickly, over the space of days or weeks.
- Other parts of the cycle, especially those involving the storage of carbon underground, may take millions of years to complete.
- Human activity is disrupting the carbon cycle balance. The amount of carbon being stored in sinks is no longer equal to the amount produced by sources
- This is leading to an increase in the amount of carbon in the atmosphere as humans produce carbon dioxide far faster than the natural sinks can absorb it.
- The greater the amount of carbon dioxide in the atmosphere, the greater the warming from the greenhouse effect.



Rondiel / Wikimedia



Juniper Photon / Unsplash

More Resources

What is Carbon Sequestration? - Conserve Energy Future

<https://www.conserve-energy-future.com/carbon-sequestration.php>

“Canada’s forests actually emit more carbon” - CBC

<https://www.cbc.ca/news/canada/calgary/canada-forests-carbon-sink-or-source-1.5011490>

Main sources of carbon dioxide emissions - What’s Your Impact

<https://whatsyourimpact.org/greenhouse-gases/carbon-dioxide-emissions>

“Earth’s rocks can absorb a shocking amount of carbon” - National Geographic

<https://www.nationalgeographic.com/science/2019/10/earth-rocks-can-absorb-shocking-amount-of-carbon/>

“Planting Trees can’t counter carbon emission” - CBC

<https://www.cbc.ca/news/technology/trees-carbon-emissions-bob-mcdonald-1.4132679>

Ocean-Atmosphere CO2 Exchange - NOAA

<https://sos.noaa.gov/datasets/ocean-atmosphere-co2-exchange/>

Human-Induced Climate Change - The Canadian Meteorological and Oceanographic Society (CMOS)

https://www.cmos.ca/site/ps_pos_statements?a=7

Videos

What are carbon sinks? | Sustainability for all - ACCIONA

<https://www.youtube.com/watch?v=OoW2PlvMpZs>

“A breathing planet off balance” - NASA

<https://www.youtube.com/watch?v=xk11DVaAjEA#action=share>