Soil Carbon Investigation Teacher Guide

Earth & Space Science Curriculum Link:

Represent the carbon cycle and examine how combustion, photosynthesis and respiration rely on interactions between Earth's spheres.

Geomechanics Focus:

Exploring carbon sequestration and soil properties.

Background Information

Figure 1: CO_2 from the atmosphere is captured by plants and stored in soil

Soil acts as a major carbon sink. Organic matter in soil stores carbon, influencing climate and environmental health. Factors such as soil type, moisture, temperature, and land use practices affect how much carbon can be retained and for how long.

Carbon sequestration, the process of capturing and storing carbon dioxide to prevent it entering the atmosphere, is a major area of current climate research. Soils represent one of the largest natural carbon reservoirs on Earth, and improving soil carbon storage is considered a practical and scalable strategy for mitigating climate change. Land management practices such as reforestation, regenerative agriculture, reduced tillage, and restoring degraded soils can increase the amount of carbon stored underground.

This exercise links directly to real-world scientific efforts to address climate change. By exploring how soil properties influence carbon retention, students are investigating the same principles scientists use when assessing carbon sequestration potential and developing strategies to reduce

atmospheric greenhouse gases.

You can watch the demonstration video here.
A presentation for the following activity is provided in this teaching package.

Aim

Collect soil samples from different areas and test for organic content using drying, weighing, and burning to understand carbon retention.

Materials

- 3-4 Soil samples (garden, bushland, urban park)
- Hand lenses
- 3-4 aluminium trays
- 3-4 Crucibles/evaporation basins
- Tripod and gauze mat
- Bunsen burner
- Heatproof mat
- Tongs
- Scale (accurate to 0.01 g if possible)
- Oven (set to ~105°C)
- Safety glasses and gloves

Safety Notes

- Wear safety glasses and gloves at all times.
- Handle hot crucibles with tongs.
- Keep hair tied back and avoid loose clothing.
- Perform in a well-ventilated lab under teacher supervision.
- Never leave the Bunsen burner unattended.

Method

1. Run through the PowerPoint presentation provided in the teaching package.
2. Prepare samples

- Collect soil samples and remove large stones or debris.
- Record initial observations (colour, texture, grainsize).

Figure 2: Collecting soil

3. Weigh wet soil
   - Place soil in aluminium tray.
   - Record the wet mass.
4. Dry in oven
   - Place aluminium tray in an oven at ~105°C for 24 hours to remove all moisture.
   - Allow to cool in a desiccator or on a heatproof mat.
   - Weigh again and record the dry mass.
5. Burn off organic matter
   - Put 10-20 g of the soil into a crucible & weigh.
   - Heat the crucible strongly over a Bunsen burner for 20–30 minutes. The soil should turn lighter in colour as it loses organic content.
   - Allow to cool completely.
   - Weigh again and record the final mass.

Figure 3: Burning off carbon content with Bunsen burner

6. Calculate organic content
   - Moisture Loss (full sample): Wet mass – Dry mass
   - Organic Matter Loss (10-20 g sample): Dry soil mass – Post-ignition mass
   - Express organic matter as a percentage of the original dry mass:

$$Organic\ Matter\ (\%) = \frac{Organic\ Matter\ Loss\ (g)}{Dry\ soil\ Mass\ (g)} \times 100$$

If you are doing this activity at home, your school does not have access to Bunsen burners, or you cannot safely perform the combustion step, you can still explore soil carbon content using safe, low-tech alternatives:

Option 1: Colour-Based Estimation

- After oven drying (or air drying), compare soil colour:
  - Darker soils generally have higher organic matter.
  - Lighter soils usually have less organic matter.
- Students can rank samples from darkest to lightest and discuss why colour relates to carbon content.

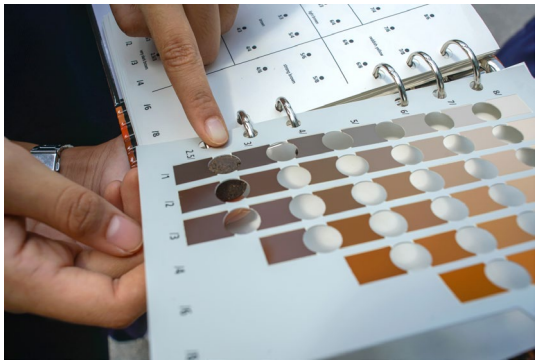

Figure 4: Using a soil chart to describe the colour of soil

Option 2: Water Float Test

- Place a small amount of soil in a clear jar of water.
- Shake well and let settle for 24 hours.
- Organic matter (plant debris, humus) will float or form a layer on top, while mineral particles sink.
- Students can visually estimate which sample has more floating material.

See our Soil Components YouTube video (AusEarthEd) for more details.

Results

Results will vary.

- Bushland soil: Higher organic matter (darker soil).
- Urban soil: Lower organic matter.
- Garden soil: Moderate, depending on compost use.

Discussion

1. Which soil had the highest organic content?
   Answers with vary

2. How does land use affect soil carbon?
   Urban areas often have less organic matter due to disturbance and paving.

3. Why is soil carbon important for environmental health?
   It stores carbon, reducing atmospheric CO_2 and supporting plant growth.

Extension: Research carbon sequestration techniques in agriculture and their role in climate

change mitigation.

Possible sources:

CSIRO. Soil carbon. Retrieved January 6, 2026, from https://www.csiro.au/en/research/natural-environment/land/soil/soil-carbon

Local Land Services NSW. (2023, June 28). Australia's first soil carbon sequestration project – overview, results and what's next? [Video]. Youtube. https://www.youtube.com/watch?v=Pn80FOh7Qn8

Resource Consulting Services Australia. (2023, July 12). What is Carbon Farming & What is an ACCU? [Video]. Youtube. https://www.youtube.com/watch?v=kVhxyMFHnOA

Dr Elaine's Soil Food Web School. (2019, Nov 16). Soil Carbon Sequestration and the Soil Food Web | Soil Food Web School [Video]. Youtube. https://www.youtube.com/watch?v=ECHYChDUfhQ

Regenerative Farmers of America. (2024, June 22). Studies Found 7 Ways to Sequester Carbon are Equal in Regenerative Agriculture [Video]. Youtube. https://youtu.be/nfvtosTygvE

What Geomechanics Is and Why It Matters

Geomechanics is the study of how soil, rock, and Earth materials behave, forming a critical foundation for the design and performance of modern infrastructure. It enables engineers and planners to develop safe, efficient, and sustainable structures, such as buildings, tunnels, roads, and dams, by providing accurate ground models and an understanding of how the ground responds to natural and human-induced changes. Geomechanics also contributes to public safety by helping identify and manage geohazards such as landslides, sinkholes, and ground instability, supporting climate resilience, sustainable development, and the global energy transition. Through proactive ground assessment and risk evaluation, geomechanics helps prevent infrastructure failures, reduce project delays, and lower financial and social costs. Careers in geomechanics span a wide range of roles, including field investigations, laboratory testing, data analysis, and engineering design, with entry pathways commonly through geology, civil engineering, and environmental science. Alternative routes, such as experience in construction, surveying, or environmental monitoring, also provide effective foundations for moving into the field. Professionals develop skills in technical analysis, communication, critical thinking, and multidisciplinary collaboration, supporting informed decision-making across infrastructure and environmental projects.

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Soil Carbon Investigation

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Aim

Collect soil samples from different areas and test for organic content using drying, weighing, and burning to understand carbon retention.

Materials

Per small group:

- 3-4 Soil samples (garden, bushland, urban park)
- Hand lenses
- 3-4 Aluminium trays
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- Tripod and gauze mat
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- Tongs
- Scale (accurate to 0.01 g if possible)
- Oven (set to ~105°C)
- Safety glasses and gloves

Safety Notes

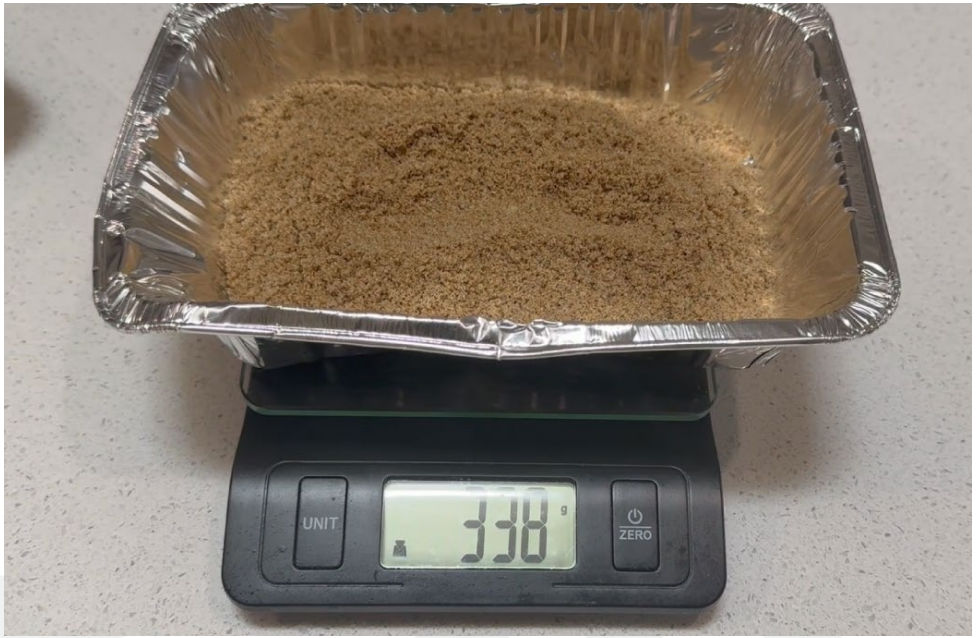
- Wear safety glasses and gloves at all times.
- Handle hot crucibles with tongs.
- Keep hair tied back and avoid loose clothing.
- Perform in a well-ventilated lab under teacher supervision.
- Never leave the Bunsen burner unattended.

1. Prepare samples

- Collect soil samples and remove large stones and debris
- Record initial observations (colour, texture, grainsize)

2. Weigh wet soil

- Place soil in a foil tray (wash your hands if not wearing gloves)



- Record the wet mass

3. Dry in oven

- Place aluminium tray in your oven at ~105°C for 12-24 hours to remove all moisture.

3. Dry in oven (continued)

- Allow to cool in the oven or on a desiccator or on a heatproof mat.

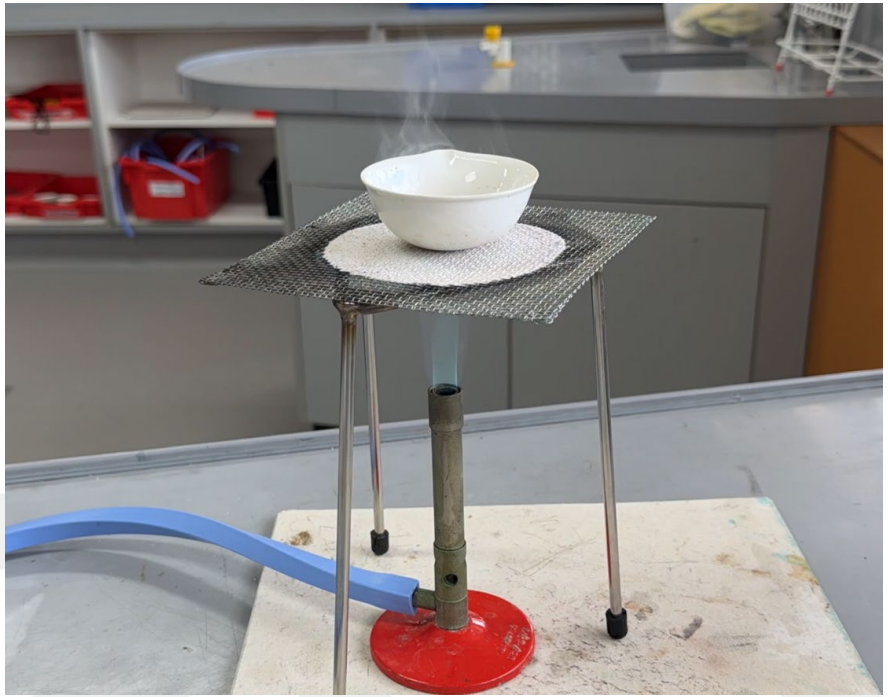
- Weigh again and record the dry mass. Calculate the moisture loss (wet mass – dry mass)

4. Burn off organic matter

- Put 10-20 g of the soil into a crucible & weigh.

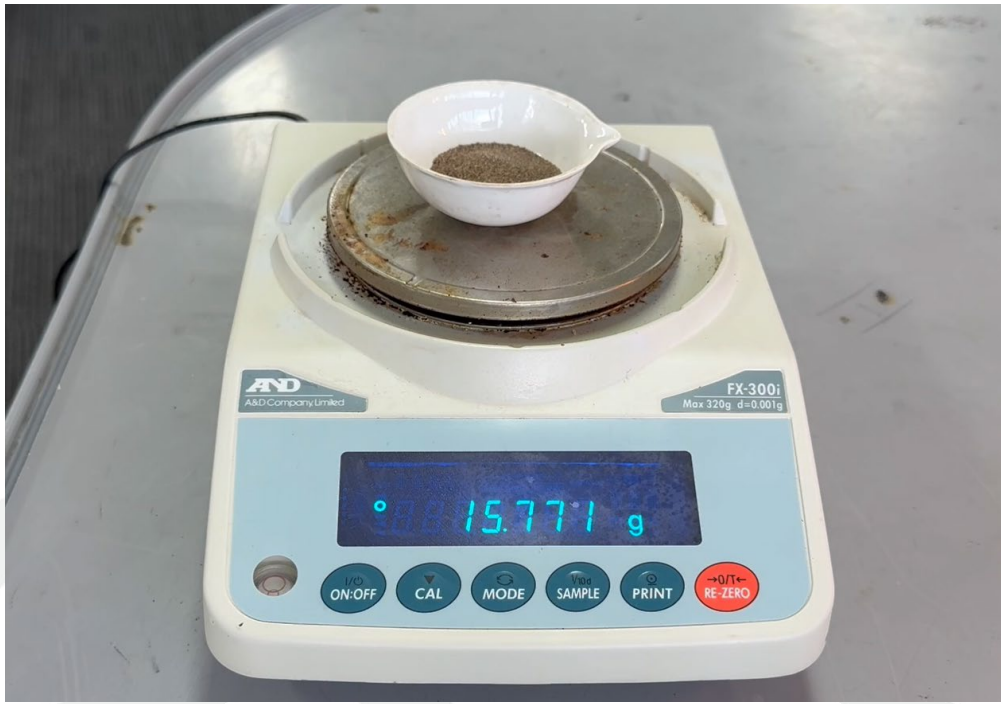
4. Burn off organic matter (cont.)

- Heat the crucible strongly over a Bunsen burner for 20–30 minutes. The soil should turn lighter in colour as it loses organic content.



4. Burn off organic matter (cont.)

- Allow to cool completely.
- Weigh again and record the final mass.



5. Calculate organic content

- $Organic\ matter\ loss = Dry\ soil\ mass - Post\text{-}ignition\ mass$

- Express organic matter as a percentage of the original dry mass:

$$Organic\ matter\ (\%) = \frac{Organic\ matter\ loss}{Dry\ soil\ mass} \times 100$$

e.g.,

$$Organic\ matter\ (\%) = \frac{2g}{19g} \times 100 = 10\%$$

Results

- Bushland soil: Higher organic matter (darker soil).
- Urban soil: Lower organic matter (lighter soil)
- Garden soil: Moderate organic matter

Discussion

1. Which soil had the highest organic content?
2. How does land use affect soil carbon?
3. Why is soil carbon important for environmental health?

Extension

Ask students to research carbon sequestration techniques in agriculture and their role in climate change mitigation

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