

Carbon Cycle Pre-quiz

1. Carbon is found in:
 - a) the atmosphere
 - b) a plant
 - c) the ocean
 - d) fossil fuels
 - e) you
 - f) all of the above

2. The carbon cycle begins with photosynthesis in plants.
 - a) true
 - b) false

3. Most of the mass in trees comes from:
 - a) the soil
 - b) the water
 - c) the air
 - d) none of the above

4. How do living things convert the food they eat into the energy they need to live and grow?
 - a) decomposition
 - b) respiration
 - c) photosynthesis

5. What organisms live in the soil?

6. What role do the soil organisms play in the carbon cycle?

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Carbon Cycle in the Soil

Cut out the carbon cycle processes and components below, and arrange them on the template on the following page to make a mini soil carbon cycle.

Processes



Photosynthesis

Respiration

Respiration

Decomposition

Decomposition

Components



Carbon dioxide in the air

Carbon in plant shoots and roots

Carbon in soil organic matter

Carbon in sugars

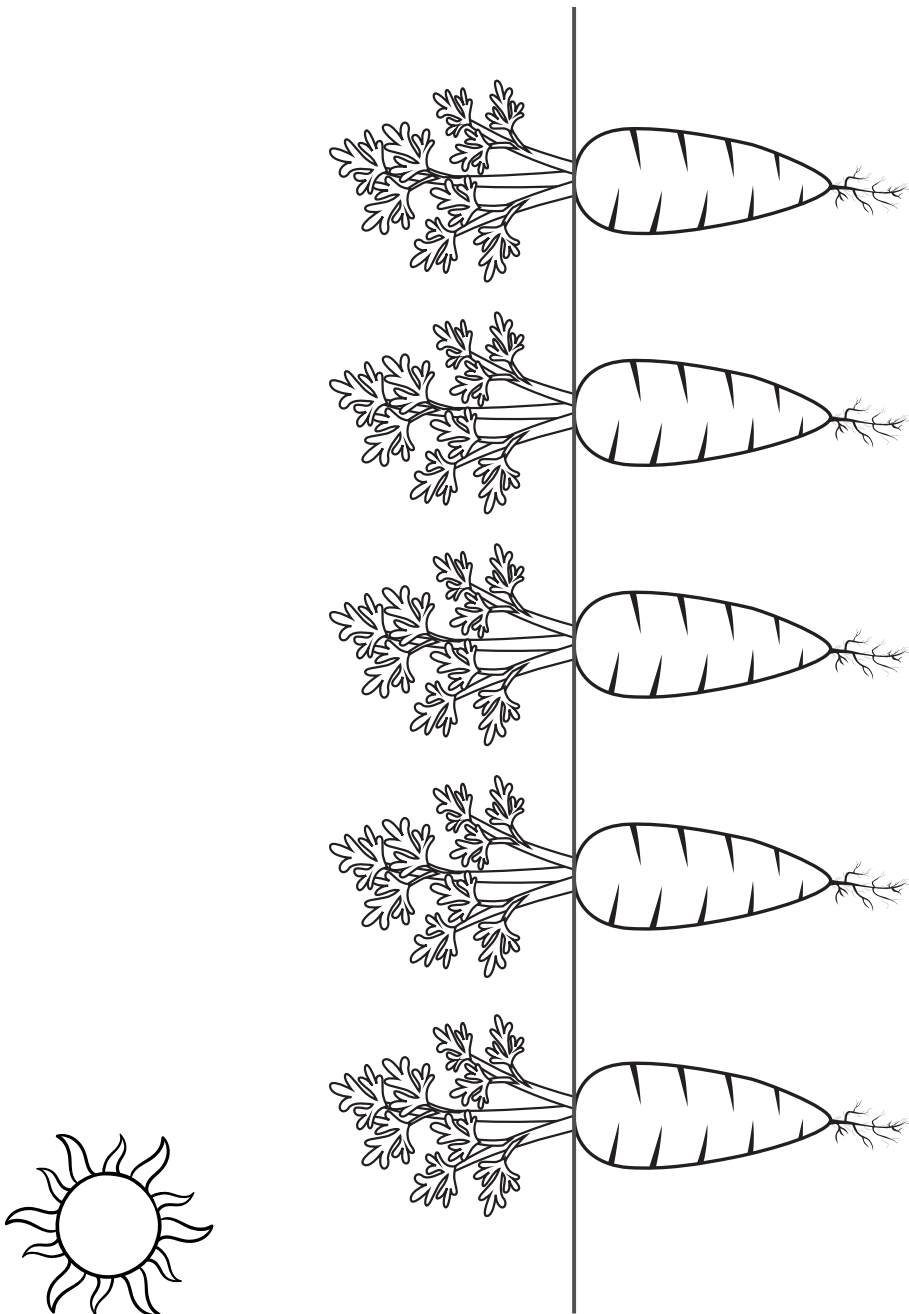
Carbon dioxide in the soil

Carbon dioxide in dead plants, animals and microbes

Carbon in soil, organisms and microbes

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Carbon Cycle in the Soil



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Fungi and the Wood Wide Web



Fungi play an important role in recycling carbon through soil and supplying plants with the nutrients and water they need to grow and thrive. How?



Scan the QR code, or click on the [link \(VIEW 7\)](#) to view the video.

▶ **Fungi and the Wood Wide Web** (4:59)
<https://www.youtube.com/watch?v=vYoRMT1szdU>

1. Prediction — From the title of this video, make at least two predictions about what you think it might be about.

a)

b)

2. Main points — What are the key ideas that Octavia wants you to know about the role of fungi in the forest?

a)

b)

c)

d)

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Fungi and the Wood Wide Web

(cont.)

3. **Questions** — What questions do you have about this video?

a)

b)

c)

d)



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Improving Our Soil Quality

What roles can the government play in supporting effective farming practices that improve soil quality in Australia?

Scan the QR code, or click on the [link](#) to read the article from The Conversation and answer the following questions.

▶ **Pay dirt: \$200 million plan for Australia's degraded soil is a crucial turning point.**

<https://theconversation.com/pay-dirt-200-million-plan-for-australias-degraded-soil-is-a-crucial-turning-point-160704>



1. According to the article, what are the four actions that the National Soil Strategy will take to achieve its goals?

- a) _____

- b) _____

- c) _____

- d) _____

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Improving Our Soil Quality (cont.)

2. The article's authors also recommend three actions that would improve the outcomes of the National Soils Strategy. What are they?

a)

b)

c)

3. The authors included another recommendation in the article. What was it?

4. What recommendations would you make to the government to improve the National Soils Strategy?

Farming Fungi



In this task, you will learn more about how mycorrhizal fungi can be used to improve crop production using a three-level reading guide.

Scan the QR code, or click on the [link \(VIEW 9\)](#) to view the video.

▶ **Farming Fungi** (4:15) <https://www.abc.net.au/gardening/how-to/farming-fungi/9435460>

Read the article ‘Farming Fungi’ and complete the three-level reading guide below on your own. A three-level reading guide helps you to ‘dig below the surface’ when you read a text.

Decide whether each of the statements below is True (T) or False (F). Make notes about the reasons why you chose each option. You will be asked to share your reasons with the class later in the activity.

Three-level reading guide

- 1. Level one – Literal** (What ideas are actually mentioned in the text?) True False

 - a) Mycorrhizal fungi competes with its host plant for food.
 - b) Mycorrhizal fungi provide plants with nutrients and water.
 - c) Tomato plants grown with mycorrhizal fungi grow bigger.
 - d) When plant roots die, their mycorrhizal fungi produce spores.

- 2. Level two – Interpretative** (What ideas can I infer from the text?) True False

 - a) Mycorrhizal fungi grow well around the roots of plants like marigolds, peas and spring onions.
 - b) Mycorrhizal fungal spores can survive in the soil for long periods.
 - c) When their plants die, the mycorrhizal fungi survive.
 - d) Plants with lots of mycorrhizal hyphae are more likely to die in a drought. ...

- 3. Level three – Applied** (How can these ideas be applied to situations? You can also use your own background knowledge.) True False

 - a) To meet our future global food needs, we have to add more artificial fertilisers to crops.
 - b) To meet our future food needs, we need to invest in more research into the role that soil microorganisms play in ecosystems — both natural and those managed by humans.

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Fruitful Tomatoes



You are a soil scientist and have been asked to help a family farming tomatoes. Their tomato yields are declining, as is their farm income. In addition, the family would like to make their farming enterprise more sustainable. You test soil samples from the cropping land on the farm and find that the soil is a bit low in phosphorus and organic matter.

Your task:

Use the information provided on the [Farming Fungi](#) webpage to write a paragraph explaining why the farmers should consider encouraging the growth of mycorrhizal fungi in the soil to improve their tomato crop. Complete the PEEL writing template to structure your paragraph.

PEEL writing template	
Point — State your point in one clear topic sentence.	<hr/> <hr/> <hr/> <hr/> <hr/>
Evidence — What evidence supports your recommendation?	<hr/> <hr/> <hr/> <hr/> <hr/>

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Fruitful Tomatoes (cont.)

PEEL writing template

Explain your point in one or two sentences.

Link back to your topic sentence.



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Earth System – Diagram Examples

The following diagrams show an example of the steps used to begin an Earth system diagram (Figures 1–10).

It starts with the question: How is the atmosphere connected to plants (the biosphere)?



Figure 1.

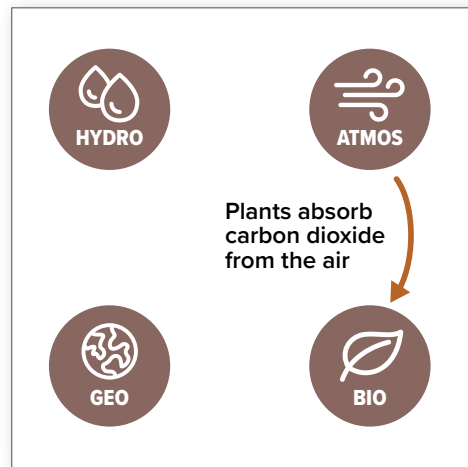


Figure 2.

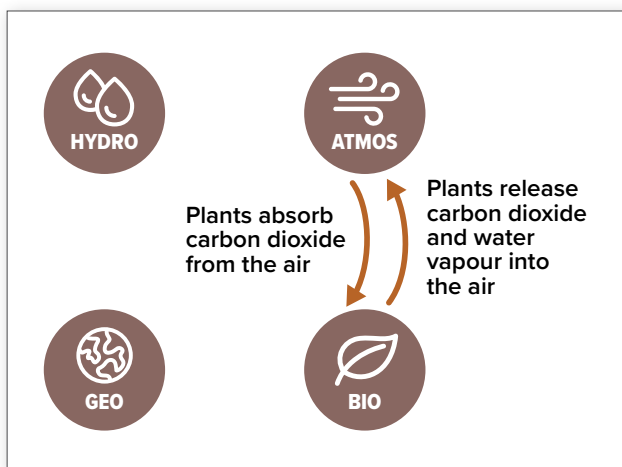


Figure 3.

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Earth System – Diagram Examples (cont.)

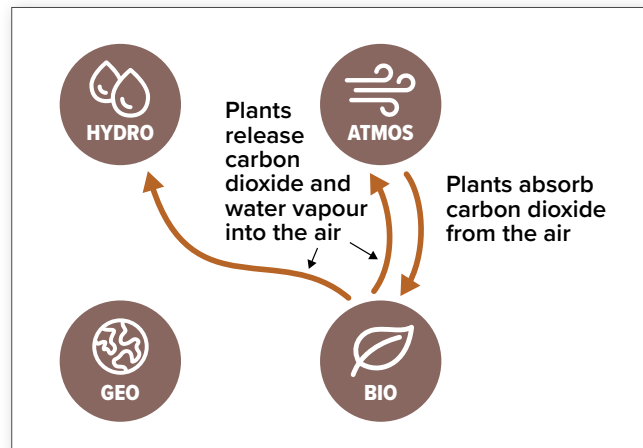


Figure 4.

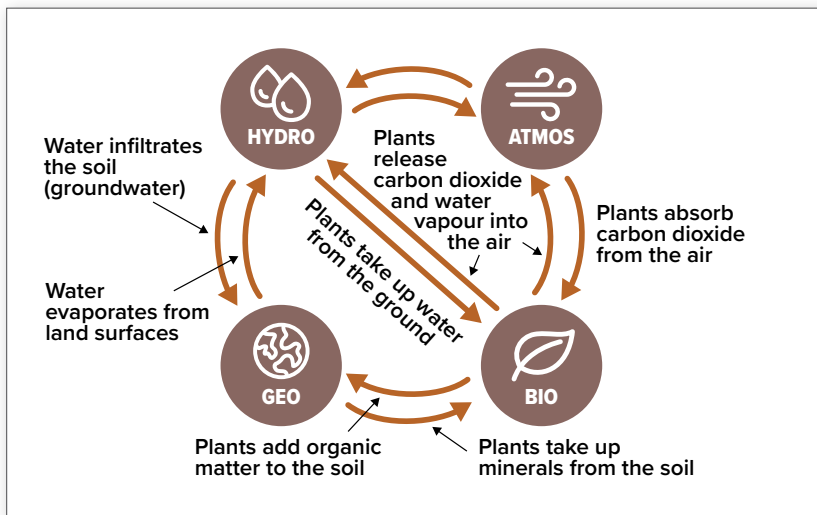


Figure 5.

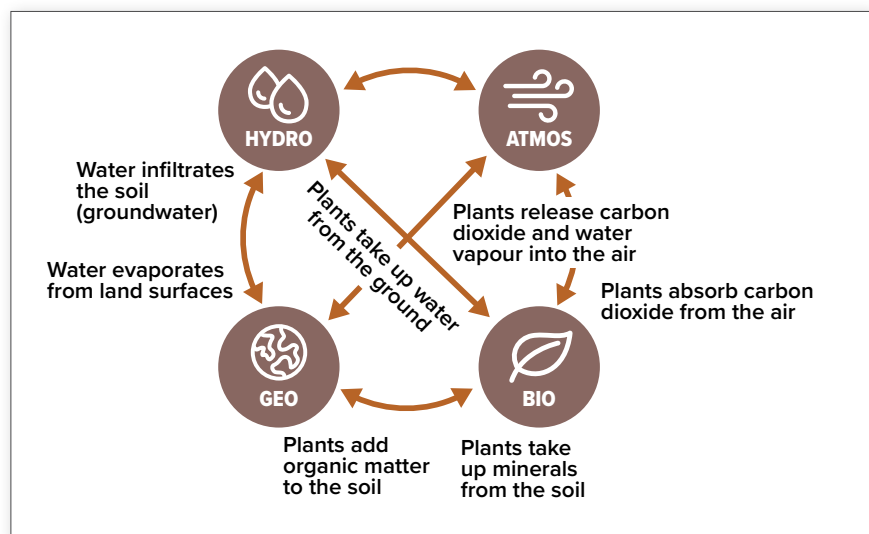


Figure 6.

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Earth System – Diagram Examples (cont.)



Figure 7.

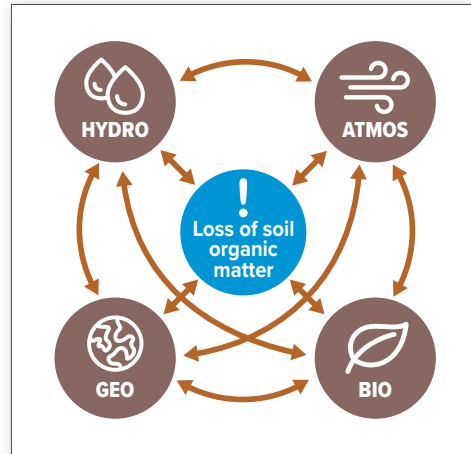


Figure 8.

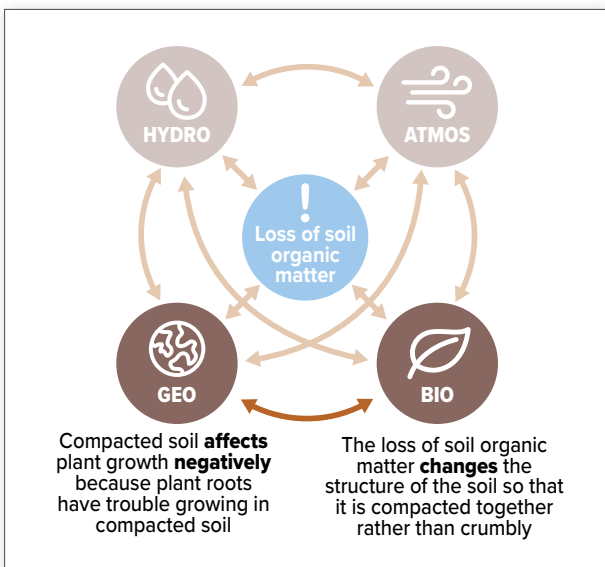


Figure 9.

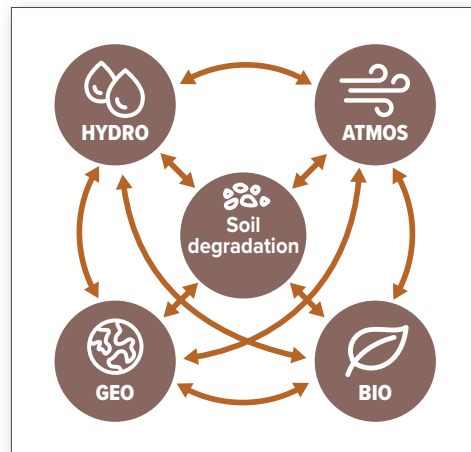


Figure 10.

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Feeding the World

How can scientists use the idea of the Earth's spheres to address complex global problems such as feeding the world?

Qu Dongyu, the Director-General of the Food and Agriculture Organization of the United Nations (FAO), said:



World Trade Organisation (2019). Qu Dongyu – 7 October 2019. CC BY-SA 2.0. via Wikimedia Commons

“As much as 95 percent of global food production depends on soil. However, unsustainable agricultural practices, the overexploitation of natural resources and a growing population are putting increased pressure on our soils. A third of them are already degraded, and experts estimate that soil erosion could lead to a 10 percent loss in crop production by 2050’ (FAO, 2022).

Qu Dongyu also believes that ‘freedom from hunger is a basic human right, and that in the 21st century we have the capability to eradicate chronic food insecurity’. While challenges loom, Qu’s cardinal principle is that problems can also be the source of progress (FAO, n.d.).

1. Use the text from Qu Dongyu to answer the following guiding questions.

a) What is the issue?

b) What is the Earth science event?

c) What is changing?

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Feeding the World (cont.)

3. Use your notes from task 2 to write at least two cause-and-effect sentences about how the loss of soil organic matter affects the planet. For each sentence, also identify which spheres are interacting.

Hint: A cause-and-effect sentence uses keywords like: causes, affects, effects, increases, decreases, changes, impacts.

For example: *The loss of soil organic matter (the event) **changes** the structure of the soil so that it is compacted together rather than crumbly. (Biosphere affects the Geosphere)*

Cause-and-effect connection between the event and two of the Earth spheres	Which spheres are interacting?
<p>Example: Soil organic matter keeps water in the soil.</p>	<p>The biosphere affects the hydrosphere.</p>
<hr/> <hr/> <hr/>	<hr/> <hr/> <hr/>
<hr/> <hr/> <hr/>	<hr/> <hr/> <hr/>

4. Why do environmental scientists use the Earth system approach to analyse global problems?

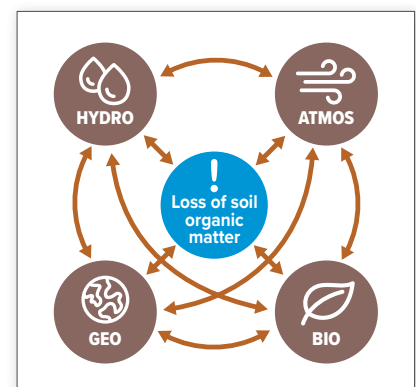


Figure 8. Event: Loss of soil organic matter

Tackling Soil Degradation



1. Why are our soils degrading?

Scan the QR code, or click on the [link](#) to view poster from the Food and Agriculture Organization of the United Nations (FAO) Soil Doctors Programme.

► Why are your crops not growing well <https://www.fao.org/3/ca2200en/ca2200en.pdf>

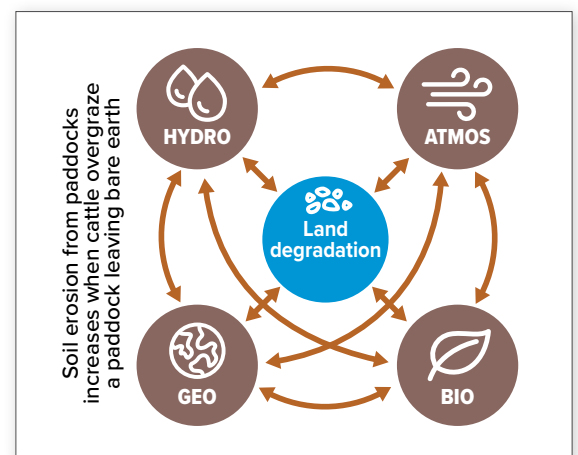
List the eight causes of soil degradation shown in the poster.

- a) _____ b) _____
- c) _____ d) _____
- e) _____ f) _____
- g) _____ h) _____

2. Using the 'Earth system diagram' to describe the soil degradation issues

- a) Working in groups of four, design a large 'Earth system diagram' that shows the interactions between the causes and effects of different soil degradation issues. The easiest way to create the diagram is to use a large sheet of poster paper or butchers paper. Draw the 'Earth system diagram' on the poster paper and add the cause-and-effect sentences on sticky notes close to the arrows that link the interacting spheres involved. Add arrows to show links between different cause-and-effect sentences.

Alternatively, your group could work collaboratively online using an app such as [PowerPoint on the Web](#). You can change the slide size to 36 inches by 36 inches and draw the 'Earth system diagram' using the Design tab. You can also work on the desktop version of PowerPoint and cut and paste elements onto the main diagram (Worksheet 3.5a, Figure 1). See right for an example.



Example

Tackling Soil Degradation (cont.)

- b) Each group member chooses one of the soil degradation issues highlighted by the FAO infographic and researches that soil degradation issue (e.g. what causes the problem?, How the impacts of the problem can be fixed or, at least, improved?).

You need to gather enough information about your soil degradation issue to be able to write some cause-and-effect sentences to add to your group 'Earth system diagram' (refer to the connection keywords in [Worksheet 3.5a – Feeding the World](#)).

Some soil degradation topics include:

- Water erosion
- Loss of soil carbon (organic matter loss)
- Nutrient imbalance
- Soil salinity (salinisation)
- Soil acidity (acid sulfate soils)

Key terms for online research include soil health, soil condition, and Australia.

You will find some starter links about soil degradation topics on [Worksheet 3.5c – Soil Degradation Links](#).

- c) At the same time, record possible solutions to the problem. This will be needed later in the activity.
- d) Complete the 'Earth system diagram' for the 'Event: Soil degradation'. Then compile a list of agricultural practices that will assist in reducing soil degradation for the four soil degradation causes your group researched. As a group, present your 'Earth system diagram' and your findings in your communication mode of choice for your audience, e.g. report, presentation, video, podcast, animation etc.

Soil Degradation Links



The following links provide a starting point to research soil degradation both at a global and local scale. Use the terms listed to search for additional websites. Other terms include 'soil health', 'soil condition, Australia'. The FAO Soil Doctor Programme infographics are useful for an international perspective on soil degradation.

Soil degradation

- a.** **▶▶ Australia State of the Environment Report 2021 – Soil**
(Australian Government)
<https://soe.dcceew.gov.au/land/environment/soil>


- b.** **▶▶ Soil degradation** (2019) (NSW Department of Primary Industries)
<https://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation#:~:text=Soil%20degradation%20is%20the%20decline>


- c.** **▶▶ Save Our Soils** (2019) (Soil Science Australia)
<https://www.soilscienceaustralia.org.au/about/save-our-soils/>


- d.** **▶▶ Land Degradation** (Agriculture Victoria)
https://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_land_deg


- e.** **▶▶ What is a Healthy Soil? Fact sheet** (2020) (State of NSW (New South Wales))
https://www.ils.nsw.gov.au/_data/assets/pdf_file/0020/1270541/11-What-is-a-Healthy-Soil_FINAL.pdf



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Soil Degradation Links (cont.)

Soil degradation (cont.)

- f. **FAO Soil Doctor Programme** (infographics and posters — 2020
(scroll down the page))
<https://www.fao.org/global-soil-partnership/pillars-action/2-awareness-raising/soil-doctor/en/>



Topics include What is soil erosion; How to best minimise soil erosion by water; How to minimise soil erosion by wind; What are soil nutrients; How to manage soil nutrients; What is soil organic matter; How to enhance soil organic matter; What are saline and sodic soils; How to prevent soil salinisation and sodification; How to manage salt-affected soil; What is soil acidification; How to minimise soil acidification.

Soil erosion

- a. **Erosion** (Queensland Government)
<https://www.qld.gov.au/environment/land/management/soil/erosion>



Wind erosion

- a. **Wind erosion** (2020) (NSW Government)
<https://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/wind-erosion>



Soil carbon loss

- a. **Soil Organic Matters** (2019) (Tasmanian Government)
<https://nre.tas.gov.au/agriculture/land-management-and-soils/soil-management/soil-structure/organic-matter>



- b. **Soil carbon** (2019) (NSW Government)
<https://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/soil-carbon>



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Soil Degradation Links (cont.)

Soil salinity

- a. **Soil salinity** (2020) (State of Victoria)
https://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_land_deg_soil-degradation_soil-salinity



- b. **Salinity** (Queensland Government)
<https://www.qld.gov.au/environment/land/management/soil/salinity>



Soil acidity

- a. **Acid sulfate soils** (Queensland Government)
<https://www.qld.gov.au/environment/land/management/soil/acid-sulfate>



Soil fertility Earth system diagram

- a. **The integral concept of soil fertility**
<https://www.fao.org/3/cc0900en/cc0900en.pdf>

You might be interested in viewing an Earth system diagram about soil fertility that was recently published by FAO. It can be found on page 19 in a 2022 report entitled [Soils for nutrition: state of the art](#). The Integral concept of soil fertility infographic describes the key properties and components that affect soil health using the Earth Systems framework.

