FOREST LEARNING

Teacher

Year 11 Earth and Environmental Science

Practical Investigation of Soils.

Teacher Overview

During this lesson, students will engage in a series of experimental and research activities to develop their knowledge of soil characteristics and test for different soil types and properties. Teachers may choose to conduct the lesson as workstations or individual/group investigations (or even complete components on, or as, an excursion task). Students will also connect their understanding of soil properties to the forestry industry.

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Stage

Year 11 Earth and Environmental Science

Syllabus Links

Outcomes

Content

Conduct a practical investigation to examine soil types and component materials (ACSES020)

Conduct investigations, including using map and field location techniques and rock and soil sampling and identification procedures, safely, competently and methodically for the collection of valid and reliable data (ACSES003)

NSW Syllabus for the Australian Curriculum

A student:

- Conducts investigations to collect valid and reliable primary and secondary data and information EES11/12-3
- Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media EES11/12-4
- Analyses and evaluates primary and secondary data and information EES11/12-5

NB: schools will need to complete their own risk assessments for the experiments contained in this lesson.

Lesson Overview

Activity 1: Practical investigation to examine soil types and component materials

Students will complete all, or a selection of, soil tests during this phase of the lesson. Teachers are encouraged to adapt this part of the lesson to their individual classroom needs. Examples would be to:

- print the documents and allow students to rotate through them as a series of workstations, or
- allow students to work individually or in small groups to complete the activities.

All materials and methods have been included in the student worksheet. Some components of the experiments could also be conducted in the field if the school completes an excursion. Students could test soil in the areas that they visit or collect samples and test on their return to the laboratory.

Practical tests outlined within this resource:
(timing approx. 80- 120 minutes if all activities are completed individually)

- Activity 1.1 - Soil Profile Modelling (edible model)
- Activity 1.2 – pH
- Activity 1.3 – Texture
- Activity 1.4 – Simple Infiltration Rate
- Activity 1.5 – Organic Matter
- Activity 1.6 – Bulk Density
- Activity 1.7 – Porosity

Activity 2: Forests and Soils

(Approx 15 minutes)

Students will complete a brief case study relating soils to the forestry industry and gain an understanding of how soils must be managed to maximise growth in the industry.

References

1. Soil Horizons Help Teaching.com, published 27th November 2017 https://www.youtube.com/watch?v=yOWH83YF3Bc Accessed on 12th July 2017.
2. Queensland Government. How soils are formed. https://www.qld.gov.au/environment/land/soil/soil-explained/forms Accessed 23rd August 2017
3. University of Hawaii at Manoa. Soil Nutrient Management for Maui County https://bit.ly/2vKChgk Accessed 21st July 2017.
4. AusGeo News Preliminary Soil pH map of Australia http://www.ga.gov.au/ausgeonews/ausgeonews201003/soil.jsp Accessed on 21st July 2017
5. Australian Government Geoscience Australia: Preliminary Soil pH map of Australia, March 2010 http://www.ga.gov.au/webtemp/image_cache/GA16735.pdf accessed on 19th July 2017
6. Agriculture Victoria http://agriculture.vic.gov.au/agriculture/farm-management/soil-and-water/soils/soil-structure-monitoring-tools Accessed 16th July 2017.
7. Agriculture Victoria; Victoria resources online, Accessed on 17th July 2017
8. http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/soilhealth_texture_grg Food and Agriculture Organization of the United Nations **https://bit.ly/2qXJgh6** Accessed 20th July 2017.
9. By Soil Physics at English Wikipedia - Transferred from en.wikipedia to Commons by Quedel using CommonsHelper., Public Domain, https://bit.ly/2HZhgRE
10. 2015 International yeas of Soil http://www.fao.org/soils-2015/news/news-detail/en/c/285569/ Accessed on 10th July 2017.
11. Soilquality.org.au Fact Sheet Bulk Density http://soilquality.org.au/factsheets/bulk-density-measurement 2017 Accessed 23rd July 2017
12. Measuring Bulk Density https://www.youtube.com/watch?v=Rt1qD7Ldhng December 2016 Accessed 23rd July 2017
13. Soil Quality Bulk Density http://soilquality.org/indicators/bulk_density.html September 2011 Accessed 23rd July 2017
14. Earth Science Week Soil properties http://www.earthsciweek.org/classroom-activities/soil-properties 2017 Accessed 17th of July 2017
15. Rainmachine Zones Soil https://support.rainmachine.com/hc/en-us/articles/228001248-Soil-Types 2013-2017 Accessed 17th of July 2017
16. GeoScience Video Porosity and Permeability https://www.youtube.com/watch?v=8mfBomrw0rs July 2015 Accessed 23rd July 2017
17. Queensland Government Business Queensland https://www.business.qld.gov.au/industries/farms-fishing-forestry/forests-wood/plantation-forestry/soil Accessed on 18th July 2017

Resources

Activity 1

- *NB: schools will need to complete their own risk assessments for the experiments contained in this lesson.*

Soil Test	URL's	Practical Materials
Soil profile modelling (edible profile)	Source: Soil Horizons, Help Teaching.com. URL: https://www.youtube.com/watch?v=yOWH83YF3Bc Source: Queensland Government. How soils are formed. URL: https://www.qld.gov.au/environment/land/soil/soil-explained/forms	• Clear plastic short cups • Prepared pudding – chocolate and vanilla • Chocolate biscuits • Green shredded coconut • Chocolate chips • Caramel chips • Gummy Worms • Spoons • Serving utensil
pH	Source: Australian Government Geoscience Australia: Preliminary Soil pH map of Australia, March 2010. URL: http://www.ga.gov.au/webtemp/image_cache/GA16735.pdf	• Soil sample • White tile • Stirring rod • Universal indicator • Barium sulphate powder • pH colour chart
Texture		• Soil samples • Water • Texture chart/table 5
Simple infiltration		• 6 equal size buckets • 6 equal size tin cans with both ends removed (or use one and repeat) • Sand • Bag of potting mix "A" (any variety) • Marker • 6 Plastic rulers • Stopwatch • Measuring jug/ beaker 500ml • Water

Organic matter		• Evaporating basin • Soil sample • Bunsen and matches • Tripod and gauze mat • Tongs • Stirring rod • Electronic beam balance • Safety goggles, • Fume cupboard
Bulk Density	**Source**: Soilquality.org.au Fact Sheets Bulk Density Measurement. **URL**: http://soilquality.org.au/factsheets/bulk-density-measurement **Source**: Measuring Bulk Density Published on 14 Dec 2016 UWSP Soil Physics Final Project. **URL** https://www.youtube.com/watch?v=Rt1qD7Ldhng **Source**: Soil Quality for Environmental Health. **URL** http://soilquality.org/indicators/bulk_density.html	
Porosity	**Source**: GeoScience Video Porosity and Permeability. **URL**: https://www.youtube.com/watch?v=8mfBomrw0rs	• 3 metric measuring cups • 100 ml graduated measuring cylinder • Water • Marking pen • Soil samples: sand, clay and small pebbles (can be obtained from various field locations such as a rock quarry, road cuts, stream beds, etc.

Activity 2

Source: Queensland Government: Business Queensland (scroll to the bottom of the page to find the heading "*Plantation forestry rules of thumb*"). **URL:** https://www.business.qld.gov.au/industries/farms-fishing-forestry/forests-wood/plantation-forestry/soil

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Sample Answers

Activity 1

Activity 1.1 - Soil Profile Modelling (edible model)

Task A:

TABLE 1: Soil Horizons

Horizon	What is it made of?	Where is it on the Horizon scale?	One Interesting Fact
O	Ground layer of organic matter incl. leaves, twigs and insects	Top layer	The organic matter is broken down by decomposers to form humus
A	Mix of minerals and organic matter	Under layer O	Its dark brown to black
B	This layer has less organic matter and more clay and other minerals	Under layer A	Fine materials are washed down into this layer
C	Mostly rock fragments from the weathering of layer R	Under layer B	No nutrients or animals are found in this layer
R	Soil bedrock	Bottom of the soil profile	The type of bedrock that weathers can determine the soil formed

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Task B: Label the picture below to show the location of the soil horizons present in the photo

Task C:

Table 2 Drawing of soil horizons in cup

Responses will depend on materials chosen by students

Table 3 Ingredients and why they were chosen

Responses will depend on materials chosen by students

Questions:

1. Describe in your own words what a soil horizon is

A layer of soil with different properties from the surrounding layers.

2. What horizon typically has the most material?

Layer B.

3. What is organic material?

Living and dead plant and animal material.

4. Describe the material found in the lowest layer of the soil profile

The material is bedrock. It is solid rock that has not been weathered.

5. Explain what the parent material in a soil profile is

It is the material that is at the bottom of the soil profile from which the soil forms.

Activity 1.2 – pH

Task: Visit the link provided and create a rough sketch (with key) of the distribution of soil pH types in Australia. Distribution of soil pH map as per link:

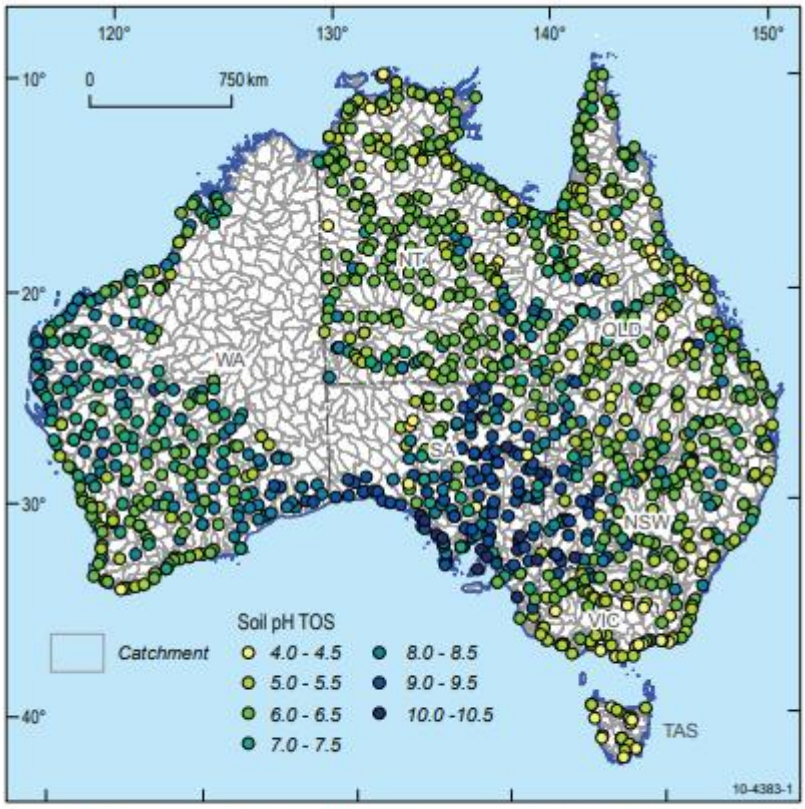

Figure 2. Distribution of soil pH values determined in Top Outlet Sediments (TOS) by the National Geochemical Survey of Australia. The symbols are coloured according to the pH recorded at the sampling site.

Activity 1.3 – Texture

Sample answer to Questions:

1. Explain why it is important to know the different amounts of sand, silt and clay in a soil sample.

Soil texture is an extremely important property of soil. The different fractions of sand, silt and clay will determine its ability to support plant life, support infrastructure or fulfil whatever role in an environment/ecosystem that it is intended. For example, high percentage sand soils will be very permeable to water and lower in nutrients- therefore not suitable for cropping and may also not be suitable to build heavy buildings on without adequate stabilisation. Soils that are silt, clay, sand loams are more likely to be higher in nutrients and retain water that is more suitable for supporting plant growth and allow effective penetration of roots. Knowing the texture of a soil will allow for better management decisions for its use.

2. Explain why soils of different textures will have different permeability and infiltration rates.

The size of the soil pores is of great importance with regard to the rate of infiltration (movement of water into the soil) and to the rate of percolation (movement of water through the soil). Pore size and the number of pores closely relate to soil texture and structure, and also influence soil permeability. Usually, the finer the soil texture, the slower the permeability.
(source: www.fao.org/fishery/static/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm)

Activity 1.4 – Simple Infiltration Rate

2. Explain how and why your results might change if you were to place a number of bricks/weights on the soil samples prior to the test.

This weight would cause the soil particles and components to compact, leaving less air space between the particles. This would result in lower/slower infiltration rates as the water would not move as freely through the air spaces in the soil.

3. Identify what "real life" scenario question 3 trying to model?

Soil compaction (possible causes from heavy vehicles or animal hooves).

Activity 1.5 – Organic Matter

1. Explain why a soil that contains low organic matter will also have a low microorganism count and discuss why this is undesirable for a productive ecosystem.

The organic matter component of soil is the living organisms and their waste materials in addition to the dead and decomposing matter within the soil. Soils that are low in organic matter will not attract living organism which rely on the breakdown of these materials for their energy needs. This in turn will means that the cycling of nutrients back into the soil is minimal and will not support plant life.

Activity 1.6 – Bulk Density

Task A: Background

The soil bulk density (BD), also known as dry bulk density, is the weight of dry soil (M_{solids}) divided by the total soil volume (Vsoil). The total soil volume is the combined volume of solids and pores which may contain air (Vair) or water (Vwater), or both (Figure 1). The average values of air, water and solid in soil are easily measured and are a useful indication of a soils physical condition.

Soil BD and porosity (the number of pore spaces) reflects the size, shape and arrangement of particles and voids (soil structure). Both BD and porosity (Vpores) give a good indication of the suitability for root growth and soil permeability and are vitally important for the soil-plant-atmosphere system (Cresswell and Hamilton, 2002; McKenzie et al., 2004). It is generally desirable to have soil with a low BD (<1.5 g/cm3) (Hunt and Gilkes, 1992) for optimum movement of air and water through the soil.

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Task B:

Materials:

1. Equipment
2. Soil sample area
3. Soil core sampler or shovel
4. Tin
5. Knife
6. Electronic balance
7. Oven
8. Ruler
9. Calculator

Method

1. Collect a soil core from a sample area
2. Remove the soil core ring from the sample
3. Using a knife flatten the edges of the soil core ring
4. Weigh and record the mass of an empty tin
5. Empty the ring of soil into the tin
6. Place the tin in an oven set at 40°C for 24 hours
7. After the soil is dry, reweigh and record the mass of the tin
8. Calculate the weight of the soil using the formula below

(Weight of dry soil + tin) – Weight of the tin

9. Measure and record the height and diameter of the tin
10. Calculate the soil volume

$$\text{Area} = \pi r^2$$

Volume = area x height

11. Calculate the Bulk Density (g/cm^3)

Oven dry soil weight (g) / Volume of Sample (cm^3)

Task C:

Outline the problems when bulk density is too high. Answers can include:

- Low soil porosity
- Soil compaction
- Restriction to root growth
- Poor movement of air and water through soil
- Shallow plant rooting
- Poor plant growth
- Reduced crop yield
- Reduce vegetative cover to protect soil from erosion
- Reduce water infiltration into soil
- Increased runoff and erosion
- Waterlogged soils

Activity 1.7 – Porosity

Task A:

Hypothesis

That the sand will have the greatest porosity as it has the largest pore spaces compared to the clay and silt.

Task B:

Video Answers

1. What can ground water be used for?

   Domestic purposes or agriculture

2. Explain the source of most useable groundwater

   Water falls as rain and seeps into the rocks below the grounds surface it can be found in the spaces between sand and gravel

3. What is porosity? Draw a diagram to explain your answer

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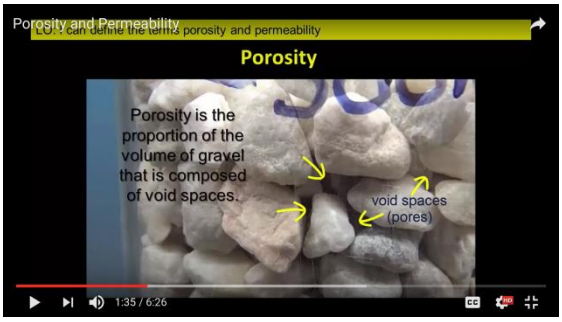
Porosity is the proportion of the volume of gravel that is composed of void spaces



4. Using a flow chart, summarise the experiment that shows how porosity can be calculated

Fill a beaker with 300mL of small rocks

↓

Fill a beaker with 200mL of blue dyed water

↓

Pour the water into the beaker of small rocks

↓

Calculate the amount of water added to the top of the rocks

(200mL – amount in the beaker after filling the rocks = amount added to the rocks)

↓

Calculate the porosity

(Amount of water added to rocks/300mL x100 = ____ %)

5. Stop the video after the water is poured into the sand. Write a prediction about which will hold more water, the gravel or the sand

Students write a prediction - either gravel or sand.

6. Outline how water is extracted from below the ground

   Water is extracted using wells.

7. Define the term permeability

   Permeability is the capacity of water to flow through earth materials.

8. Describe the permeability and porosity in an igneous rock

   Igneous rocks with gas bubbles that are not connected will have good porosity poor permeability.

9. Identify which type of soil had the greatest permeability

   Faster the flow of water the higher the permeability. The gravel has the highest permeability.

10. Outline which rocks are the best suited for groundwater reservoirs

    Sand and gravel because of their combination of good porosity and permeability.

Task C: Soil Activity Porosity

The results table and conclusion answers will depend on the student's individual results.

Teacher

Activity 2: Forests and Soils

TABLE 6: Soil related decisions in plantation forestry

1	• Select species that are suitable for the soil and rainfall available.
2	• Cultivate the planting rows to provide a good growing environment for the young plants.
3	• Deep rip if the site has been used for intensive agriculture in the past. This will assist in root penetration into lower soil depths and promote tree growth.
4	• Plant the seedlings deep into the soil. Cover the potting mix with 3-5 cm of soil. If the soil is dry, water the seedlings in.
5	• Maintain a weed-free soil by using herbicides. This reduces competition for resources. A bare earth perimeter around the tree (1m radius) for the first 12 months will greatly enhance growth and survival.
6	• Make sure you remain on top of weed control during growth.

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