Soil sense

Janet Hutson

Janet gives an overview of what a teacher needs to know for teaching soils at key stage 3 and suggests a range of practical, engaging classroom activities.

Accompanying online materials

A soil is a mixture of inorganic (mineral) and organic particles organised into layers (horizons) by physical, chemical and biological processes. Although the importance of soils cannot be overestimated, some teachers may have had few, if any, lessons themselves on this topic. If they feel less than confident about the topic they might be tempted to relegate soils to a subsection of physical geography or an aside in a unit on farming. However, an understanding of the formation and maintenance of soils is an essential element of geography. This article is an overview of soils and a range of practical class activities to help you feel confident with the topic and enthuse your students.

Soils are mentioned in the 2014 National Curriculum document:

> *Understand, through the use of detailed place-based exemplars at a variety of scales, the key processes in… physical geography relating to… rocks, weathering and soils* (DfE, 2014).

This suggests that the teaching of soils fits best alongside weathering and, given the crucial role of weathering in initial soil formation, it is an understandable approach. It is therefore important to be secure in mechanical (physical) weathering processes and chemical weathering processes. The starting point is to explore soil material in general and then study specific types, from named climates or locations. It does make sense to include British examples or include regional studies of soils, working back from the specific soil type(s) found in your chosen location ('detailed place-based exemplar'). Soil can also usefully be included in other topics such as vegetation, natural resources and economic activity (see Figure 1).

What should you teach at key stage 3?

With air and water, soil is a major natural resource. It is the foundation of all ecosystems; it filters water, provides nutrients for forests and crops and helps regulate the Earth's temperature. It is the medium in which plants grow and so, directly or indirectly, the source of our food. Students should recognise that there are different types of soil and know how soil develops from a bare surface. Soil is fragile and human activities can both damage and improve soils.

Where do you start?

Here are some suggestions of how to introduce soils to your classes. This YouTube video *(www.youtube.com/watch?v=TqGKwWo60yE)*, marking the International Year of Soils 2015, gives snappy coverage of a number of key ideas. It could also be used synoptically at the end of the topic. Each frame could be made the subject of a group verbal, written or illustrative task.

Take students outside into the school grounds to a number of locations and ask 'Where is the soil?' A garden or allotment are obvious choices; but will they realise that there are soils beneath the playing field or buildings? If a path has been worn across a field, or if a concrete or paved area has been 'extended', wearing away the grass, there could be discussion as to why nothing is growing. Ask students to think about soils in their gardens or on farms, in parks or in these grounds. Is anything being done by humans to change the soil? Think about cultivation, fertilizer, weed killer, machines etc.

Students may think that soil is unimportant, so prompt them to think about how different groups of people may value soil.

Broaden your horizons

If you dig down into the earth, further than even the most enthusiastic gardener, until you reach something that is rock-like, solid or loose, you should be able to identify layers. These are horizons, and the cross-section your digging reveals is what is called a soil profile (Figure 2). In different soils, the A and B horizons will vary in a number of ways, including colour. At this point, specific soil profiles could be introduced (see the websites listed at the end of the article). You could focus on a local profile and/or those which would be found in chosen regional and national studies.

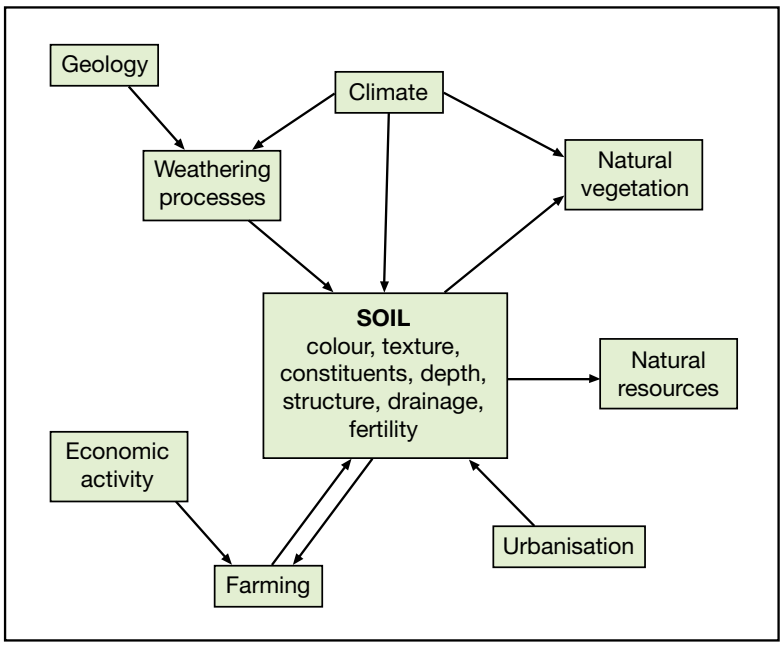
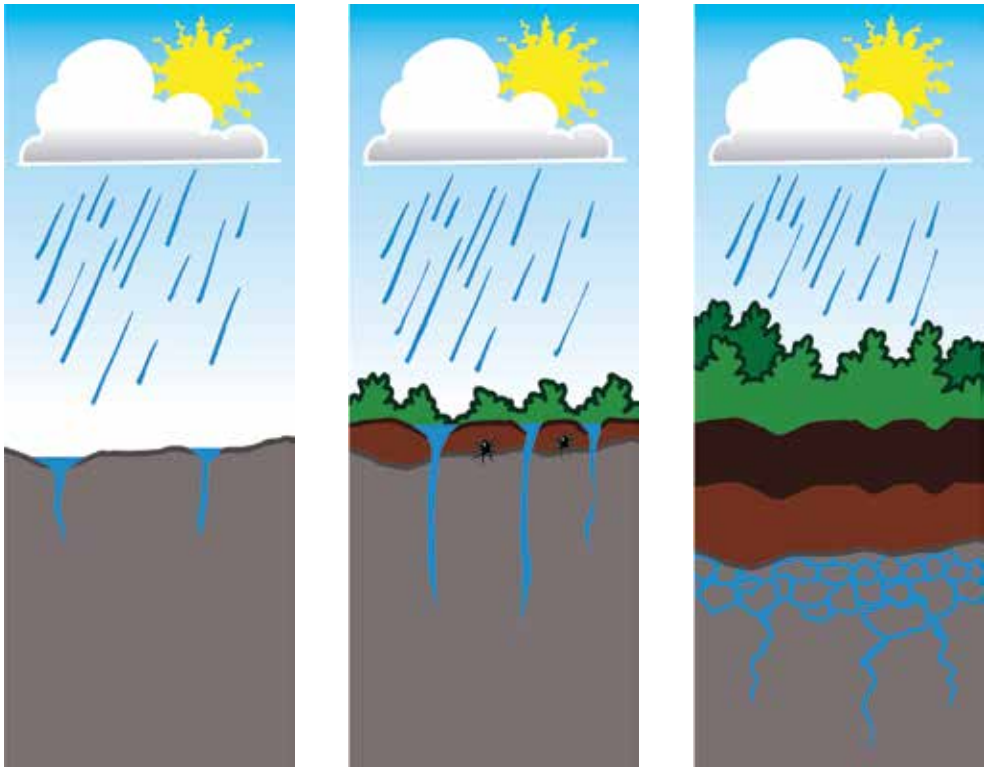


Figure 1: Soils and the National Curriculum.

Figure 2: A soil profile.

O	Organic	Plant litter in various stages of decomposition which will provide humus	This may not be evident in managed soils
A	Topsoil	Mixed mineral, e.g. well weathered rock and organic, e.g. decaying leaves	Usually dark coloured, brown or black. Contains roots, plant and animal life
B	Subsoil	Almost entirely mineral; weathered parent material	Reorganisation of material takes place. Some plant and animal life and live roots
C	Parent material	Unweathered rock	

Figure 3: How soil is formed, note the importance of water in this process



Weathering weakens and breaks up the rock, letting in water.

The decay of vegetation and fauna provide organic matter.

Movement of water redistributes material to create layers.

Online extras
A full version of the practical activities to investigate the physical properties of soil and a glossary of key terms is available to download. Go to *www.geography.org.uk/tg* and click Autumn 2015.

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Soil formation

All soil profiles are a result of three distinct processes (Figure 3).

Breakdown (weathering) of parent material This is an opportunity to revisit and reinforce weathering ideas and terminology. It is worth getting students to think about the possible types of bare surfaces, for example volcanic lava flows, glacially eroded land, even cleared concrete.

Decay and incorporation of plants and animals Decomposition of organic matter is by bacteria and fungi in the soil or in the gut of larger, soil-dwelling animals. Softer plant material like grass rapidly breaks down after death whereas harder, woody plant material breaks down more slowly.

Organisation of particles into horizons Particles are dissolved or suspended in soil water, which moves material and nutrients downwards and upwards. Water can move dissolved or suspended minerals and deposit them, causing horizons to form. Earthworms or insects can move soil material around.

Investigating soil

There are some practical activities to investigate the physical properties of soil in Figure 4. These use easy-to-source equipment and can be carried out by groups of students with soil samples brought from home or gathered around the school site and results compared. | **TG**

References
DfE (2014) 'Geography programmes of study: key stage 3.' Available online at *www.gov.uk/government/uploads/system/uploads/attachment_data/file/239087/SECONDARY_national_curriculum_-_Geography.pdf* (last accessed 9 January 2015).

Useful websites
British Geological Survey *(www.bgs.ac.uk)*. Type 'soil' into the search box to get links to many specific soil topics, including the mySoil app.
Land Information Systems *(www.landis.org.uk)*. This has very good photographs of soil profiles.
UK Soil Observatory *(www.ukso.org)*. This has a dedicated 'Schools and education' page. Some resources are American.

Activity 1: What colour are your soils?

The colour of a soil can reveal a great deal about its nature. A soil is usually described in terms of its colour: black, brown, red, grey, yellow, white. Darker colours usually indicate a more nutrient-rich soil. Grey indicates poor drainage. Red usually indicates the presence of iron and poor conditions for plant growth. This activity improves students' observation and describing techniques.

- Use a piece of A4 or A3 white card to create a table of five columns, headed: location; site; soil; description; comment.
- Have a number of small (teaspoon-size) soil samples, each from a different location. Write the locations in the first column on the chart. Write details about the site, for example the relief (steep slope, flat, etc.) in column 2.
- Press a damp finger into a soil sample then make a smear on the card in the third column.
- Repeat with all samples. Wash hands before doing repeats and then very thoroughly when all have been done.
- Allow the smear to dry then describe the colour as accurately as possible under 'description'.
- In the last column, comment on what the colour might indicate.

Activity 2: What is in your soil?

Soil has a number of components, both organic and inorganic, resulting from its formation and active processes. This activity reveals some of these, as well as the percentages of the different sizes of soil grains.

- Put 500g of soil onto newspaper.
- Use a magnifying glass to identify organic material and use tweezers to pick out any insects (dead or alive) and bits of plant; put them into separate dishes.
- To measure the coarse grains, tip the remaining soil into a wide-mesh garden or soil sieve and shake it. Put the stones and large pieces of soil left in the sieve into a dish.
- To measure the medium grains, tip the remaining soil into a kitchen sieve and shake. Put the material left in the sieve into a dish. The soil that passed through the sieve is the fine grain; put this into another dish.
- Weigh the contents of each dish. Students compare the weights and work out the percentage of each to make a pie chart.

Activity 3: What is the texture of your soil?

Soil texture is important because it influences how easily water passes through it, whether nutrients will be available to plants, and how the soil will clump (soil structure). This 'Dirty hands test' can show the soil texture.

- Take a small handful of soil and dampen.
- Roll between the fingers to feel for 'grittiness' and whether it sticks together.
- Does the soil feel gritty? Can you make a thread that breaks easily? This is a sandy soil.
- Can the soil be made into a thread but does not feel sticky? This is a loamy soil.
- Does the soil feel a bit sticky and make a thread that does not break easily? This is a clay-loam soil.
- Is the soil sticky and easy to make into a ring? This is a clay soil.
- Wash hands thoroughly when finished.

Activity 4: How much air is there in your soil?

Air sits between the particles in the soil. Soils 'breathe' by a delicate exchange of gasses, a process called aeration. The oxygen in the air is needed by micro-organisms to break down plant and animal material into humus. Humus releases nutrient (carbohydrate) energy which is taken up by plant roots and soil organisms so aeration needs to take place continuously. Soil processes release carbon dioxide which passes upwards to the atmosphere. A soil with tiny air spaces, or pores, and so less air, will not allow water or oxygen to pass through easily, and plant growth will be slow. Too much human disturbance, e.g. ploughing, breaks up the pore spaces, releasing carbon dioxide very quickly, which contributes to global warming.

- Put some soil into a measuring cylinder or jug up to the 200ml mark.
- Shake the container gently to get the surface level. Check the amount and add more if necessary.
- Carefully pour 200ml of water onto the soil.
- When the water has settled, read off the level at the top of the water.
- The difference between your level and 400ml is the amount of air in your soil.

Activity 5: How acid is your soil?

Soil acidity affects what can grow in a soil and how well it grows. Most plants do best in a soil slightly more acidic than neutral but some need a very specific level of acidity to do well. The acidity can depend on the parent material, the rainfall and what is growing in it. People can change the acidity of the surface levels of a soil.

- Bring about 1 litre of distilled water to boiling point then cool a little.
- Chop up about half of a red cabbage and put into the water. Stir and leave for about an hour then sieve into a jug.
- Put samples of soil into clean glass jars and add some red cabbage water. Shake gently then allow to settle.
- Compare the colours of the soil water. The pinker it is, the more acidic; the bluer, the less acidic.

Activity 6: What type of soil?

The *mySoil* app from the British Geological Survey (BGS, © NERC) can be used on a Smart phone or tablet. Once loaded, you can access map-based soil information for the whole country. When you first use the app, it should show you the map of your own area. If not, tap the GPS symbol at the top right corner of the map. Students can identify the characteristics of the soils at various locations or with a whole class go to *www.ukso.org/SoilsOfEngWales/home.html* and click the Map Viewer. This takes you to a blank map and dialogue box into which you type a postcode or place name. Soil information will be revealed for that place when the map has reloaded for the appropriate location.

Figure 4: Practical activities to investigate the physical properties of soil. A full version of these activities is available to download.