



Soil

The soil is the **upper layer** of the Earth's surface and is the basis for terrestrial life on our planet. It is thought of as a living system, because it is inhabited by a wide variety of living organisms and is in a constant process of formation and destruction (erosion). The soil has a unique property – fertility.

Soil formation is a lengthy process. The soil can be seen as a complex formation resulting from the permanent circulation of substances and energy between the living organisms (plants, animals and microorganisms) and the non-living nature (rocks and minerals). A 30-centimetre layer takes from 1,000 to 10,000 years to form. The process is so long that the soil can be considered a non-renewable resource. Some 65 percent of the total surface of the Earth's continental area is covered in soil (about 14.8 billion hectares). Of this area, less than one-third can be directly used for agricultural activity: pastures, meadows and arable land.

The following **factors influence** soil formation: the proto-base, living organisms (plants, animals, human activity, microorganisms), climate, topography and weather.

Soil consists of four phases:

- solid – mineral and organic substances;
- liquid – soil solution;
- gaseous – soil air; and
- living – soil organisms (microorganisms, invertebrates and burrowing vertebrates).



In the upper 30-cm layer of one hectare of soil there are about 25 tonnes of **soil organisms** like bacteria, fungi, earthworms, and coleoptera. The organisms like snails, mice and earthworms represent from 50 to 75 percent of the total weight of the living organisms in arable land. The soil flora and fauna turn the organic matter into humus, which then combines with the mineral mass. In addition, the worms create air pockets that are important for plant roots.

The soil is an important part of all **ecosystems**. Unlike protecting the atmosphere and the hydrosphere, however, the need to protect the soil has only recently been recognised. Due to its static character the soil easily soaks in various harmful substances discharged for various reasons in the environment. Since the decomposition period of these substances when they are deposited in the soil is comparatively longer than when in the air or water, the problem often remains hidden.

Unlike air and water, the soil can be **private property**, which makes its protection more difficult, since it depends on the will of owners and managers.

The soil performs six different **functions**:

- It is the basis for biomass production and food for animals, people and trees. Also, the decomposition of the dead plants and animals takes place in the soil.
- It filters, buffers and transforms. Soil purifies the underground water and acts as a natural filter and stabiliser.
- It serves as a habitat and gene reservoir, as many plants and animals grow and live in the soil.
- It serves as a foundation for the homes, public buildings and roads that are built on it.
- It is a source of raw materials for building and furnishing, and for renewable sources of fuel (e.g. straw, turf, wood refuse).
- It is a historical medium that preserves valuable historical and cultural heritage.

The layer of soil on the earth is **diminishing** and in many places its quality is **deteriorating**. We need to do our best to stop the process of soil destruction, so that it can perform all its functions. The most serious problems and threats to the soil are erosion, acidification, pollution, compaction and salinisation.

About 75 percent of all soil on the planet has reduced productivity owing to **insufficient** humidity and heat. One of the most disturbing facts is that, due to bad management, 5-7 million hectares of fertile land is lost every year, which leads to the use of ever more natural land for increased agricultural production.

More than any other time before, human society needs to target their efforts at **protecting** the soil and **preserving** its fertility. It must diminish the negative impacts of human activities on the soil qualities as much as possible.

Lesson plan: What do we know about soil?

Duration	2-3 class periods
Time of year	Any
Place	The classroom, in the open
Materials	Blackboard (flipchart), felt pens, chalk Worksheets for colouring in A big glass or plastic jar, pebbles, sand, leaves, artificial worms and insects (can be made of paper), water, a big spoon, a magnifying glass Soil gathered from different places; 3-4 laboratory glasses, a knife, blotting paper or filter paper
Aims	<ul style="list-style-type: none"> • To acquaint the students with the soil and its basic functions and characteristics; • To visualise the components of soil • To raise awareness that soil formation takes a long time
Methods	Discussion, experiment



Part I: What is soil (Discussion)

1 On the blackboard write various words and phrases related to soil, such as:

- upper layer, part of the Earth's crust;
- covers the whole planet, covers the land;
- liquid, solid, live, fertile;
- complex mix of living and non-living nature;
- necessary, unnecessary.



Afterwards, ask the students to complete the sentences:

- The soil is
- The soil ...
- The soil is

2 Ask the students why the soil is so important for the Earth and what its main functions for living organisms and people are. Write the answers on the blackboard or on the flipchart. Facilitate by giving additional information from the introduction.

**Part II: Let's create soil (Experiment)**

1 Explain to the class that many people think of soil as dirt that needs to be kept off their shoes and washed from their hands. Ask the students what is in the soil. Add more information using the information in the introduction. Explain that not all components of the soil can be seen at first glance. Inorganic materials like pebbles, sand and clay are mixed with organic matter and live organisms. There is also water and air mixed in. Pay attention to three of the factors (climate, topography and time) that determine the formation of the soil.

The climate plays an important part in the speed with which the processes in the soil transpire. The warm geographic latitudes are favourable for soil formation. Topography refers to the fact that if the land is in the mountain or in the plains, and whether the area is sloped or level. Stemming soil erosion where the area is sloped is much harder. This is why people consider soil protection in the mountains a major priority. Emphasise to the class that soil cannot be formed by only mechanically putting together its components. Time is needed as well.

2 To prove this last point, make the following demonstration with the assistance of some of the students:

- Put some pebbles, sand and clay in an empty jar. Mix them well. Add some leaves and the artificial worms and insects. Stir again. Add some water, but do not fill the jar to the rim. Explain that in this mixture there is also air, which is necessary for animals and plant roots. Ask the class if they think this is real soil.
- Divide the class into groups and ask each group to dig up and bring two or three handfuls of real soil. (This task can be assigned in advance on the previous day to several volunteers.) Ask the students to compare the soil that has been brought to class, and the one from the experiment. Do this with and without the magnifying glass. Discuss the differences that can be seen.



3 Emphasise that soil formation is a long process, which takes many years and depends on the original base, the live organisms (plants, animals, human activity and microorganisms), the climate, the topography and the weather conditions. Explain that all of these conditions cannot be simulated in the classroom, and there would not be enough time anyways since it takes 50 to 100 years to form 1 cm of soil layer. Lead them to the conclusion that the soil should be valued and protected.

Part III: Lets study soil (Experiment)

Explain to the students that soil has many properties, but today you are going to study three of them: colour, humidity and density. For this purpose you will have to do the following research task:

- 1 Put in identical containers fresh samples of soil, taken from different places. Label the containers and draw a grid on the blackboard, as shown below:

Soil	Colour	Humidity	Density
No. 1 – From the school yard			
No. 2 – From the woods			
No. 3 – From a farm			
No. 4 –			

- 2 The **colour of the soil** depends on the presence of various chemical compounds and water.

Regarding the chemical composition there are three basic colours:

- **Black** – due to the presence of humus;
- **brown** (red, rust-coloured) – due to the presence of ferrous compounds; and
- **grey** (whitish) – due to the presence of carbonates and silicates.

The proportion of the various compounds gives nuances of the basic colour. The more humid soils always look darker. Write the study results in the first column.

- 3 The **humidity of the soil** depends on the presence of water at the moment of description. It can be rated roughly using blotting paper. Consider the following degrees of humidity:

- **Dry soil** – when touched it crumbles to dust and does not wet the blotting paper.
- **Fresh soil** – when touched it is cool, but does not wet the blotting paper.
- **Damp soil** – when held in hand it forms a ball and wets the blotting paper.
- **Wet soil** – when held in hand it drips water and is sticky.

Identify the humidity of the soils and fill in the results in the second column.

- 4 The **density of the soil** can be rated using a knife. Consider the following degrees of density:

- **Very dense** – the knife cannot penetrate the soil.
- **Dense** – the knife penetrates the soil with difficulty.
- **Rather dense** – the knife penetrates the soil comparatively easily.
- **Loose** – the soil crumbles easily.

Write the study results in the third column.

Explain that there are hundreds of soil types in the world and that their names often relate to their colour, e.g. black earth, grey forest, brown forest, etc.

Other activities

- Hand out copies of the test What Do We Know about Soil? Ask the students to do it as an individual task.

Lesson plan: **Soil and people**

Duration	3-4 class periods For the experiment: 10 minutes daily for 2 or 3 weeks, followed by discussion for 1 class period
Time of year	Any time For the experiment: preferably, during a warmer part of the year
Place	The classroom, the school lab
Materials	An apple, a pocket knife For the experiment: a plastic bag, a magnifying glass, a thermometer, stickers, little pieces of scrap (metal, chewing gum wrapping, a plastic coffee cup, an empty soft drink can, a piece of cotton cloth, a piece of glass, a piece of paper, a banana peel), some garden soil Fact sheets for colouring
Aims	<ul style="list-style-type: none"> • To demonstrate that the amount of soil in the world is by no means unlimited • To demonstrate what can disintegrate naturally in the soil • To raise awareness of the main factors endangering soil
Methods	Demonstration, experiment, discussion, brainstorming

**Part I: How much soil is on the Earth? (Demonstration)**

1 Begin the activity by asking the following questions:

- What do we all walk on daily when we go from home to school?
- When do we talk of soil and when of the Earth's surface?
- Can we call the street "pavement soil?"
- Where can we find soil in a town?

Remind the students of the role the soil plays in feeding plants, animals and people and of the importance of soil fertility.

2 Ask the students if they think there is a lot of fertile soil in the world. After hearing their suggestions, show the class an apple. Tell the students to imagine that it is a miniature model of the Earth. Explain that with your next demonstration you are going to prove that the fertile soil in the world is by far less than it seems:

- Cut the apple into four equal sections and put three of them away. Explain, that three-fourths of the Earth's surface is taken by the seas and oceans, which is not land we can use for traditional agriculture (though you may mention that there are ideas for it).
- Cut the fourth section into two and put away one half. Explain that this part of the Earth is taken by deserts, where food crops cannot be grown.
- Cut the remaining eighth of the apple into four pieces and put away three of them. Explain that the parts you put away represent the part of the Earth's surface taken up by rocks and stones — this land is not fertile.
- Tell the students that the remaining sector represents 1/32 of the Earth's surface — the portion that is considered fertile. Peel the skin of the sector explaining that this is actually the upper layer — the soil, which feeds the plants and produces food for all animals and people. Emphasise that building roads, houses and factories on fertile land diminishes the amount of soil capable of supporting crops even further.

Part II: What pollutes the soil?

1 Preparation: Organise and carry out the following experiment with the students over the course of two or three weeks:

- Fill two-thirds of a plastic bag with garden soil. Add small pieces of scrap: metal, chewing gum wrappers, plastic coffee cups, empty soft drink cans, a piece of cotton cloth, a piece of glass, a piece of paper, and a banana skin. Mix them well and pour water in the mixture. Close the bag tight and put a sticker on it with an inscription of what you have added to the soil and the date.
- Put the bag near the window in the sun (if you are doing the experiment during a warm season of the year) or near a heater (but not on it) if it is winter.
- Every day for two or three weeks, examine and note down your observations about the temperature, the smell, the outer appearance and the visible changes. If the soil in the bag looks dry, add water.



2 Discussion: After two or three weeks ask students to analyse the changes you have observed and to prepare short reports answering the following questions:

- Can you see any organisms in the mixture?
- What changes of temperature did you observe during the experiment?
- Which scraps changed and which look the same as before?

3 Determine which scraps can be assimilated by the soil and which remain unchanged. What other kinds of scrap, in the students' opinion, would not be broken down by the soil?

4 Encourage the students to share personal experience and impressions from pollution of the soil with litter, waste and/or the use of fertilisers and chemicals in farming. Lead them to understand that preserving the purity of soil is of vital importance for its properties and for the aesthetic appearance of the environment.

Part III: What endangers soil (Discussion, brainstorming)

1 Ask the students to observe, after school, the soil pollutants in the schoolyard and in the park when you go on an outing. On the basis of the experiment, have them analyse how probable it is that the litter they see will be quickly assimilated by the environment. Make short reports on their observations and read some of them to the class.

2 Hand out the worksheet What Endangers Soil? Together, discuss the main threats to the soil (pollution, compaction under road and building construction, exhaustion, erosion) and their impact on soil, on its fertility and the living organisms in the soil. Note that the state of the soil is directly related to the other components of nature — air, water, living organisms — and both depends on their condition and has its own influence on them at the same time.

3 Brainstorm possible measures which can be taken to protect the soil in the schoolyard, in the park, at the farm, and other familiar outdoor areas.

Other activities

- Ask several volunteers to form a small group and discuss in front of the rest of the class the dilemma The Garden in Autumn.
- Organise a clean-up of the schoolyard, the park or some other place.
- Ask the students to share what they have learned with their families. Tell them to make a plan, together with their parents, about the proper treatment of household refuse (for more details see the unit on Consumption) and about the protection of their garden soil.
- Study more extensively the various soils in your town or village and in your country.
- Make copies of the picture on page 131 and hand them out to the students to colour in.



DILEMMA

The Garden in Autumn

One day you get home to find the whole family in the yard gathering and throwing away the leaves which had fallen from the trees.

You decide to:

- help with throwing out the leaves;
- suggest digging a hole and burying the leaves there, where they will rot and thus make your garden more fertile;
- agree that burning the leaves is a good idea;
- do nothing and watch TV instead;
- something else.



TEST

What Do We Know about Soil?

In the sentences below there are pairs of phrases in **bold**.
Cross out the one you consider wrong to make true statements.

- 1 Soil **covers** / **doesn't cover** all land on the Earth.
- 2 A layer of 30 centimetres of soil needs **100-1,000 years** / **1,000-10,000 years** to form.
- 3 The most important property of soil is its **density** / **fertility**.
- 4 Living organisms **do not take** / **take** an active part in the formation of soil.
- 5 Because of its stationary position and due to its composition, soil **holds** / **does not hold** many pollutants.
- 6 Human activities have a major **favourable** / **unfavourable** impact on the state of soil nowadays.
- 7 Burning stubble-fields after harvesting is **good** / **not good** for the soil.
- 8 Using chemicals against pests **pollutes** / **doesn't pollute** soil.
- 9 The state of the soil **depends** / **doesn't depend** on the state of the other elements of nature – air, water and living organisms.

Answer key: 1. doesn't cover 2. 1,000-10,000 years 3. fertility 4. take 5. holds 6. unfavourable 7. not good 8. pollutes 9. depends



FACT SHEET

What Endangers the Soil?

Erosion – The fertile upper layer of the soil is good for farming, provides pasture for animals and holds nutrients for plants. When the trees, bushes and grass are taken away, the soil is unprotected and erosion begins. Erosion is the process of washing away of the soil by water and, on a smaller scale, by wind. Soil erosion can result from any human activity that exposes the soil to rain and wind. Agricultural activities like ploughing of steep slopes, removal of the vegetative soil layer, neglecting terraces, and increasing the number of grazing animals all make erosion worse.

Acidification – Depending on where it is, soil can have higher or lower levels of acid. The plants that grow there are used to these levels, and so making the soil more acidic can harm these plants. Human activities often put extra nitrogen and sulphur in the soil, through air pollution, precipitation (acid rain) and fertilisers.

Pollution – In most cases soil is polluted by metals and their compounds, organic chemicals, oils and tar, pesticides, explosives and toxic gases, radioactive or biologically active materials, fuel and other harmful substances. These things most often come from industrial and communal waste released into the soil.

Compaction – Soil is squeezed together as a result of repeated and continuous pressure from heavy machines or of cattle on wet soil terrains.

Salinisation – Soil becomes overloaded with salt because of bad irrigation equipment or direct sources of salt. The process is bad for the living things in the soil and the quality of agricultural production.

