Session 2: Living Ground: An Introduction to Soil as a Vital Ecosystem

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Overview

Learning Outcomes	Agenda and Timeline	Material
• Basic knowledge about soils as ecosystems • Use of geographical tools, working with geographical data; • soil functions; threats to soil health; • soil protection The students… • can asses various dimensions of soil health • can explain basic knowledge about soils and can categorise their functions and relevance as well as the threat to soil health • work with various soil-related tools • can characterise the soils in their region and explain their use and possible problems	170min + 10min buffer • Introduction (introduction of the people and the plan/purpose of the meeting) – 10min • Kahoot-Quiz on soil (Getting started and arousing interest) – 10min • Input by lecturer (What is soil and why do we care about it?) – 10min • Station learning on soil – 130min (incl. 10min break) • One minute paper + Take-home message – 20min • Feedback and conclusion of the session – 15min	• 9 questions for kahoot quiz • 10 stations for station learning • template and task for one-minute-paper and take-home message • feedback methods

General Information

Overall learning objective: to develop a basic understanding of soil as an ecosystem, its functions, threats and protection options

Target group: students who deal with ecological and spatial topics in various disciplines and have a heterogeneous level of prior knowledge in the field of soil science; Bachelor's and Master's students are welcome; no prior knowledge required

Time required:

Preparation: 2 hours (120 minutes)

Implementation: 3 hours 15 minutes (195 minutes)

Factual analysis:

Soil is the uppermost weathering layer of the Earth's crust consisting of mineral and organic components, the development of which is caused by the factors of rock, water, climate, relief and the living environment (Meschede et al., 2020). As a result of the soil formation processes, characteristic horizons are formed, which vary in intensity depending on the soil type and differ in color, structure, humus content and other characteristics (Meschede et al., 2020). The structure and composition of soil are closely linked to its ability to fulfill a variety of functions. Among other things, it serves as a habitat, a basis for agricultural production, a water filter, and a carbon sink (FAO & ITPS, 2015).

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However, these functions are under threat worldwide. In Europe, the main threats include soil sealing, contamination, erosion, compaction and the decline in organic carbon (FAO & ITPS, 2015). Many of these processes are slow and barely visible, but their long-term consequences are serious and often irreversible.
Protecting soil therefore requires specialized knowledge of soils as well as targeted measures to restore intact soils and promote sustainable land use (Pröbstl et al., 2025). Soil is a non-renewable resource whose conservation is a key prerequisite for food security, biodiversity, clean water, human health and climate protection (FAO & ITPS, 2015).

Didactic-methodological analysis:
This session is aimed at students who deal with ecological and spatial topics in various disciplines and have a heterogeneous level of prior knowledge in the field of soil science. The overall learning objective of this session is to develop a basic understanding of soil as an ecosystem, its functions, threats and protection options. In this way, students develop a basic technical knowledge of the central resource of soil and an awareness of its ecological interrelationships. This is an important prerequisite for being able to act in the spirit of education for sustainable development (Rinschede & Siegmund, 2022). The session thus promotes key EU Green Competences, supports interdisciplinary thinking and creates a basis for further learning formats.
The session begins with an introduction to the session and clarification of objectives in order to create transparency and give students a clear orientation for the rest of the session. The subsequent Kahoot quiz serves to playfully activate prior knowledge and assess existing understanding (Rinschede & Siegmund, 2022) and offers learners a low-threshold introduction to the topic of soil. The results of the quiz can then also be used to specifically address gaps in the group's knowledge or areas of interests.
Building on the interest generated, a knowledge base is to be created in the input phase as a foundation for the further learning process. In this phase, basic soil-related terms, functions and problems are introduced and the topic is made tangible through illustrative examples and media and a connection to the students' living environment is established (e.g. soil erosion, food security, climate protection). This phase is based on direct instruction but can be loosened up by incorporating various media (e.g. videos) (Rinschede & Siegmund, 2022).
The development phase focuses on the action-oriented method of station-based learning (Rinschede & Siegmund, 2022), in which students work independently on different topics in small groups, supporting each other and exchanging observations. In this phase, students develop both technical and methodological skills (e.g. through experiments).
With the help of a one-minute paper template, students record key results, reflect on what they have learnt and formulate their personal take-home message. This creates an individual reference to the previously almost neutral learning object (Rinschede & Siegmund, 2022).

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Finally, the session as a whole is reflected upon. This phase offers everyone involved in the learning process an opportunity for open questions, feedback on the session and discussion (Rinschede & Siegmund, 2022). Various feedback methods (e.g. five-finger method) can be used for this purpose. This phase can also be used to check whether the overall objective of the lesson has been achieved (Rinschede & Siegmund, 2022).

References:

Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils (FAO & ITPS). (2015). Status of the World's Soil Resources (SWSR) – Main Report. Rome, Italy. Retrieved from https://openknowledge.fao.org/server/api/core/bitstreams/81533344-7e7c-473d-96d7-e18de59d6548/content.

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Schedule + needed information

☑ = prepared by LOESS

Time needed	Agenda	Material	Objectives	Learning Outcomes
10min	Introduction (introduction of the people and the plan/purpose of the session)	- introductory games ☑ - schedule ☑ - learning objectives/outcomes ☑	Presentation of the session plan and, if applicable, getting to know each other	
10min	Kahoot-Quiz on soil	- Kahoot access - prepared Kahoot quiz - QR Code for access - questions ☑ - digital devices for the participants	Overview of various dimensions of soil-related topics	The students are able... - assess their level of knowledge on the subject of soil and understand the relevance of soil health. They will also gain an insight into the relevance of the session.
10min	Input by lecturer (What is soil and why do we care about it)	- short input on the relevance of soil (e.g. a video, input by lecturer etc.) Example: https://www.youtube.com/watch?v=OiLITHMVcRw&t=20s	Convey an understanding of why the topic of soil is relevant; arouse interest in further activities	The students are able... - to understand the relevance of the topic

130min (incl. 10min break) 15min per station (not all stations have tob e used)	Station learning on soil	- 10 Learning stations ✓, station card with work instructions ✓ - Station 1: Image of soil profile ✓; Arrows ✓; worksheet ✓; examples of soil types, station card with work instructions ✓ - Station 2: Information cards ✓; blank sheets; glue; pens, station card with work instructions ✓ - Station 3: Memory ✓; blank sheets, pens; station card with work instructions ✓ - Station 4: Illustration of soil genesis ✓; Cloze text ✓, station card with work instructions ✓ - Station 5: blank sheets; pens, station card with work instructions ✓ - Station 6: Soil network poster ✓; Post Its; Pens, station card with work instructions ✓ - Station 7: Geographical tools depending on the possibilities of the institution (examples ✓) - Station 8: Soil samples, jars with lids, water; soil samples, funnel + rack, filter paper, ink, water, measuring cup, empty jars, station card with work instructions ✓ Station 9: geological drill/ ground auger, station card with work instructions ✓	Acquisition of basic knowledge about soil-related topics KEEP IN MIND: It is possible to select only certain stations. Just make sure that you also include stations that cover basic knowledge (e.g. Station 1 and Station 2).	The students are able... - to explain basic knowledge about soils as ecosystems - to use geographical tools and work with geographical data - to describe soil functions, threats to soil health, and measures for soil protection - to categorise soil functions and relevance, and to explain threats to soil health - to apply various soil-related tools in practical contexts - to characterise regional soils and explain their uses and potential problems

		- Station 10: three different bases (e.g. field, compacted surface, sealed surface), water, measuring cup, station card with work instructions ☑		
20min	One minute paper + Take-home message	- template for one-minute-paper ☑	Self-reflection on learning success and thinking about next steps	The students are able... - to reflect on and categorise their own learning success and identify further starting points
15min	Feedback and conclusion of the session	- feedback method ☑	Reflection of the session with the group and conclusion Check whether the learning objectives have been achieved	The students are able... - to reflect on and categorise the learning success of the group

Session content and materials

Kahoot Quiz

1. What percentage of European soils are currently degraded?
a) over 20%
b) over 45%
c) over 60%
d) over 70%
2. How long does it take for 1cm of soil to form (e.g. clay soil)?
a) 10 years
b) at least 40 years of age
c) at least 70 years of age
d) at least 100 years
3. What percentage of the European area is used for agriculture?
a) 23%
b) 35%
c) 41%
d) 52%
4. How many soil organisms are in a handful of soil?
a) around 500,000
b) around 1 million
c) around 3 billion
d) around 8 billion
5. How much carbon is stored in the top 30% of soil compared to the atmosphere?
a) Less than 10% of what's in the atmosphere
b) about half as much as in the atmosphere
c) about the same as in the atmosphere
d) twice as much as in the atmosphere
6.) Which of the following best describes the role of soil as an ecosystem?
a) Soil only stores water for technical applications.
b) The soil only produces mineral raw materials.
c) Soil serves as a habitat for a variety of organisms.
d) Soil reflects sunlight to regulate the climate.
7. What types of soil are there?
a) Sand, silt, clay
b) Sand, rock, clay
c) Sandy soil, bog soil, arable soil
d) Sand, loess, loam

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8. What percentage of our diet originates in the soil?
a) more than 60%
b) more than 75%
c) more than 80%
d) more than 95%
9. What factors determine the formation of the soil?
a) Climate, vegetation, time, relief, air, man
b) Climate, vegetation, time, relief, rock, man
c) Climate, vegetation, time, relief, water, man
d) Climate, wildlife, time, relief, rock, man

Station Learning

Station cards: see powerpoint file

Part 1

Station 1: Soil types [matching game + soil type examples]
The participants are shown a picture of a soil profile and arrows with the respective horizon names. The first task is to allocate the respective horizons. Once the assignment has been made, the participants can turn the arrows over and read through the explanations. The worksheet is then handed out and filled in.

Station 2: Soil degradation (erosion, salinisation, sealing/compaction) [structural sketch]
The participants each receive an A3 sheet and the information cards. They look at these in turn and create a diagram. They can arrange them as they wish and also work with written additions (e.g. connecting arrows to show connections; headings). The aim is to create diagrams/sketches to explain soil degradation.
Alternatively, a mystery can be created from the maps. Illustrations or similar can also be added.

Station 3: Soil characteristics + soil functions [memory, blank papers]
The participants play the memory game and derive the terms from the explanations. The terms consist of soil functions and areas in which soil plays a role [natural functions and utilisation functions]. They then use the soil functions to develop a chart about soil which shows at least some of the mentioned functions.
Memory: see powerpoint file (remove the solution words!)

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Station 4: Soil development - soil genesis, soil organisms and humus formation [Diagram + cloze text]
The participants look at the diagram and discuss it with the supervisor. They should be able to understand and explain the processes shown. The cloze text is then filled in.

Station 5: Soil protection - mulching, green manure, ground cover, ... [Mind map]
The participants are each given a blank A4 sheet and an A3 sheet as a group. Firstly, they look for an field that they would like to find out more about in terms of soil protection and research it accordingly. These could be, for example: Garden, food, cosmetics, consumption, mobility, lifestyle...
They record the results of their research on the A4 sheets (e.g. a cluster). They then collate their results and create a mind map together on the topic of 'Soil protection in everyday life'.
OR: Use this station explicitly to prepare for the excursion!

Part 2
Station 6: Soil - an interconnected system
The learners recognise that soil is not an isolated resource, but has an impact on numerous topics - from climate protection, food and water to politics, the economy and culture.
Task: Take a look at the 'Soil Network Poster', which shows various topics related to soil.
Task: Choose two topics and use Post Its to answer the following questions. Stick the pieces of paper on the poster. Subsequent groups can add to it.
How is this topic related to soil?; Why is this connection important for society and the environment?; What challenges or opportunities do you see in this connection?
Terms für Poster: climate, water, agriculture, biodiversity, urban development, health, energy, economy, social justice…

Station 7: Geographical tools
This station is suitable for integrating geographical tools and working with geographical data. For example, the crowd mapping tool of the LOESS project is also suitable. In general, this station can be designed based on the existing framework conditions (materials, tools, etc.).

Station 8: Filter experiment + sludge sample
In the sludge sample, a soil sample is mixed with water and slurried. After a certain time, the soil components settle in layers according to their size and weight - first the sand, then the silt and finally the clay. This allows the soil type to be roughly determined. The filter test can be carried out during the time it takes for the sample to settle.
When rainwater falls on the ground, it can be contaminated by various pollutants that are washed out of the air or washed off surfaces. These contaminants can pollute the

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groundwater and thus our drinking water. Soils with a high filtration capacity are particularly good at cleaning rainwater.

Station 9: Taking soil profiles (determining the local soil type)
Taking soil samples with the Pürckhauer is a common method for analysing the soil at various depths. The Pürckhauer consists of a narrow, cylindrical metal tube with a sharp cutting head, which is inserted into the soil by turning and pressing it in. When it is pulled out, an undisturbed soil sample remains in the cavity of the probe, which can then be analysed orally and interpreted for the site. This method enables a quick assessment of soil stratification, moisture and soil type down to a depth of around one metre.

Station 10: Percolation test
Wind and water erosion can result in the loss of up to 400 tonnes of fertile soil per hectare per year - that's about 2 cm of soil. It takes around 100 years for one centimetre of raw soil to become one centimetre of fertile soil. The soil on which we grow our food crops is therefore ancient: the humus that makes the upper soil layer fertile is around 3,000 to 5,000 years old. The erosion experiment simulates a heavy rainfall event in three different soil situations. The method can be carried out in class without any problems.

One Minute Paper + Take Home Message

Procedure
1. The students get three questions (e.g. as a sheet, as cards or digitally):
    What is an important realisation or insight that I am taking away with me today?
    What is still unclear for me or would be worth deepening?
    What is my personal take-home message?

→ Individual work (2-3 minutes):
Everyone writes silently and for themselves. Emphasis: It's not about "right or wrong", but about your own perspective.
→ Voluntary exchange (optional, 2-3 minutes):
Those who wish to do so read out their results or it is collected in bullet points (e.g. on the whiteboard or flipchart; alternatively: digitally via Mentimeter, Padlet or Moodle forum).
2. Teacher concludes with a short summary of the points mentioned or addresses common ambiguities (possibly with references to further literature or resources).

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Print Templates

Station learning checklist

Round 1

Station	Topic	Signatur
Station 1	Soil horizons, soil types, soil types	
Station 2	Soil degradation	
Station 3	Soil characteristics + soil functions	
Station 4	Soil development – soil genesis	
Station 5	Soil protection in everyday life	

Round 2

Station	Topic	Signatur
Station 6	Soil - an interconnected system	
Station 7	Geographical tools	
Station 8	Filter test + slurry test	
Station 9	Draw soil profile – determine local soil type	
Station 10	Percolation test	

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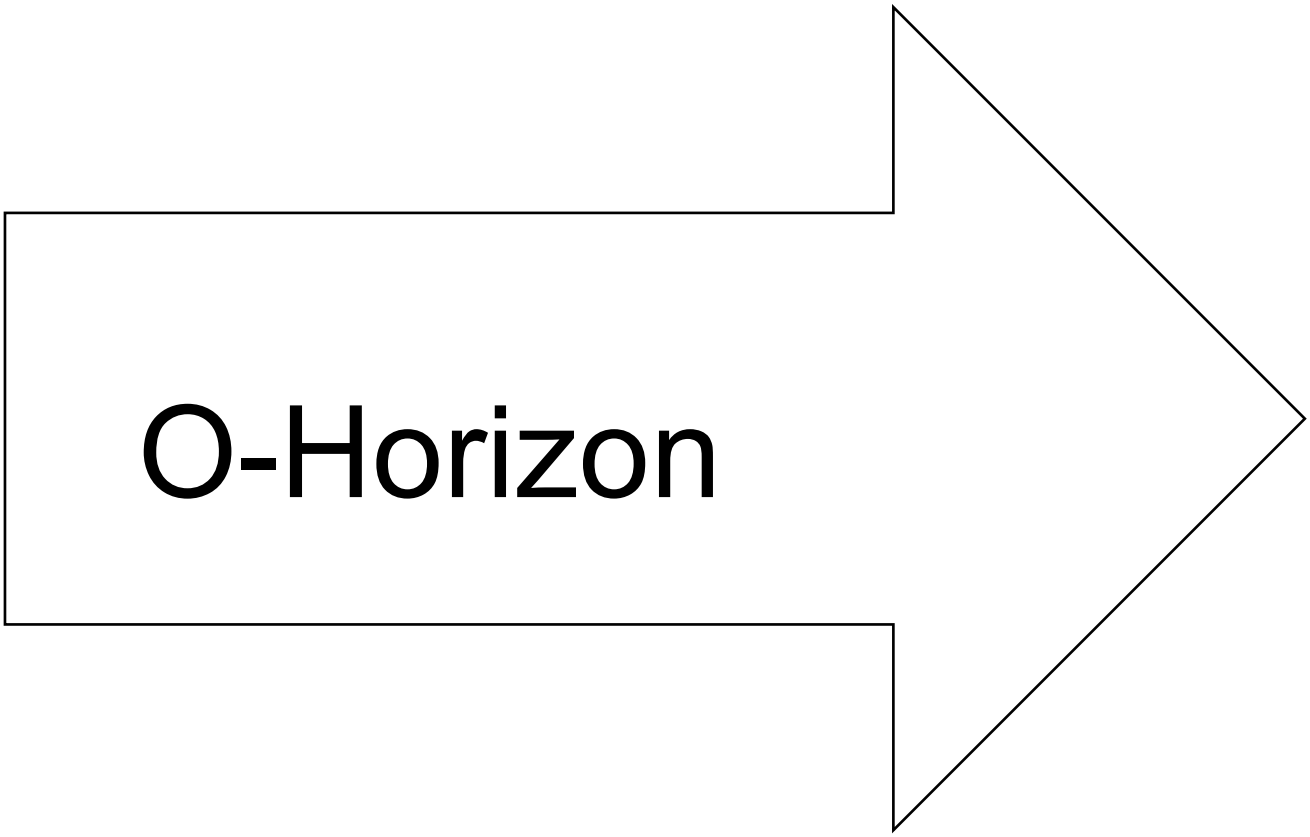
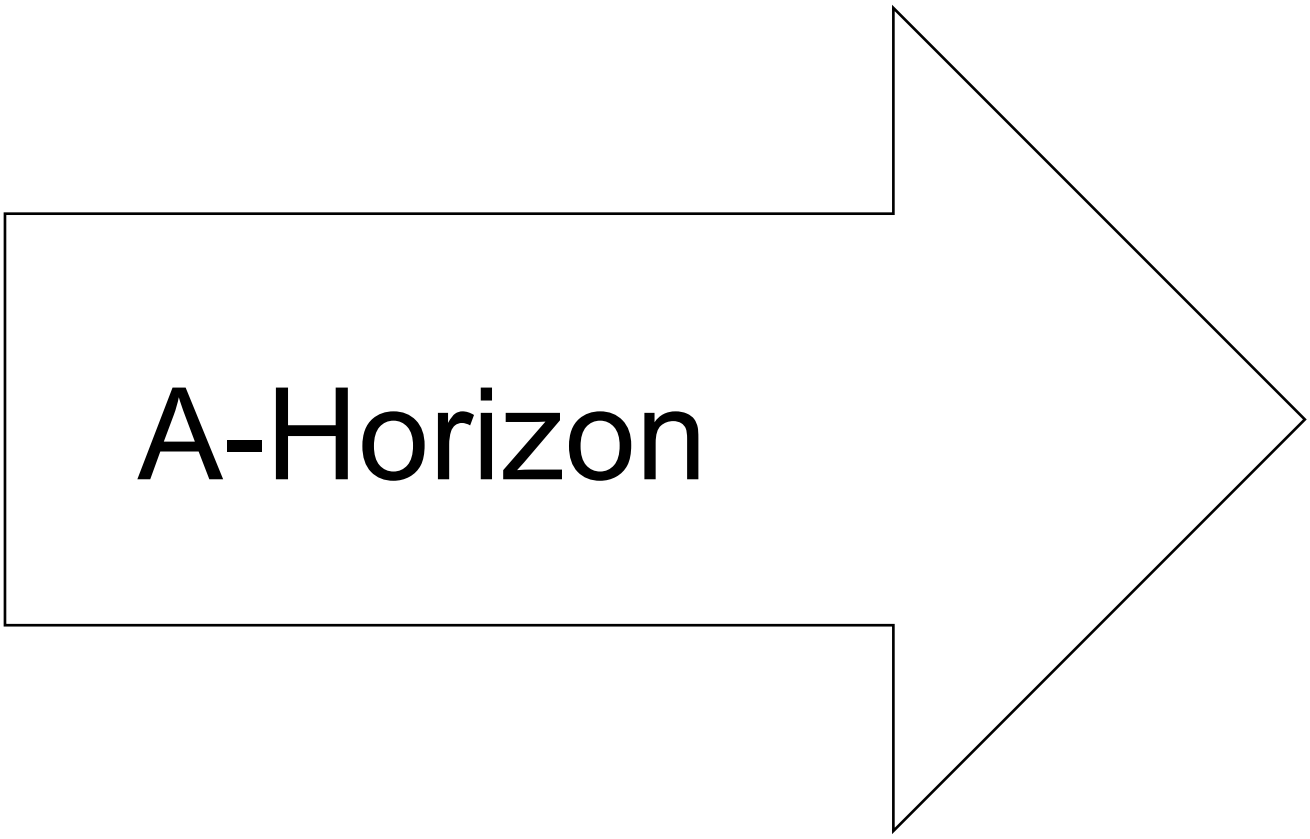
Arrows station 1





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B-Horizon

C-Horizon

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Explanations for the back of the arrows:

O horizon = organic layer

The O horizon consists of organic material such as decomposed plant remains, fallen leaves and branches, fungi, insects, earthworms...

The O horizon contributes significantly to humus formation and can also have a positive effect on water absorption and storage

A horizon = topsoil

The A horizon consists of a mixture of decomposed organic material from the topsoil and mineral material from the parent rock.

It is rich in nutrients, well aerated and provides good conditions for plant growth and the life of numerous soil organisms such as earthworms, fungi, insects and bacteria.

B horizon = subsoil

The B horizon consists mainly of mineral materials from weathered parent rock and the displacement of materials. It contains only a small amount of organic matter.

C horizon = parent rock

The C horizon consists of unweathered parent rock.

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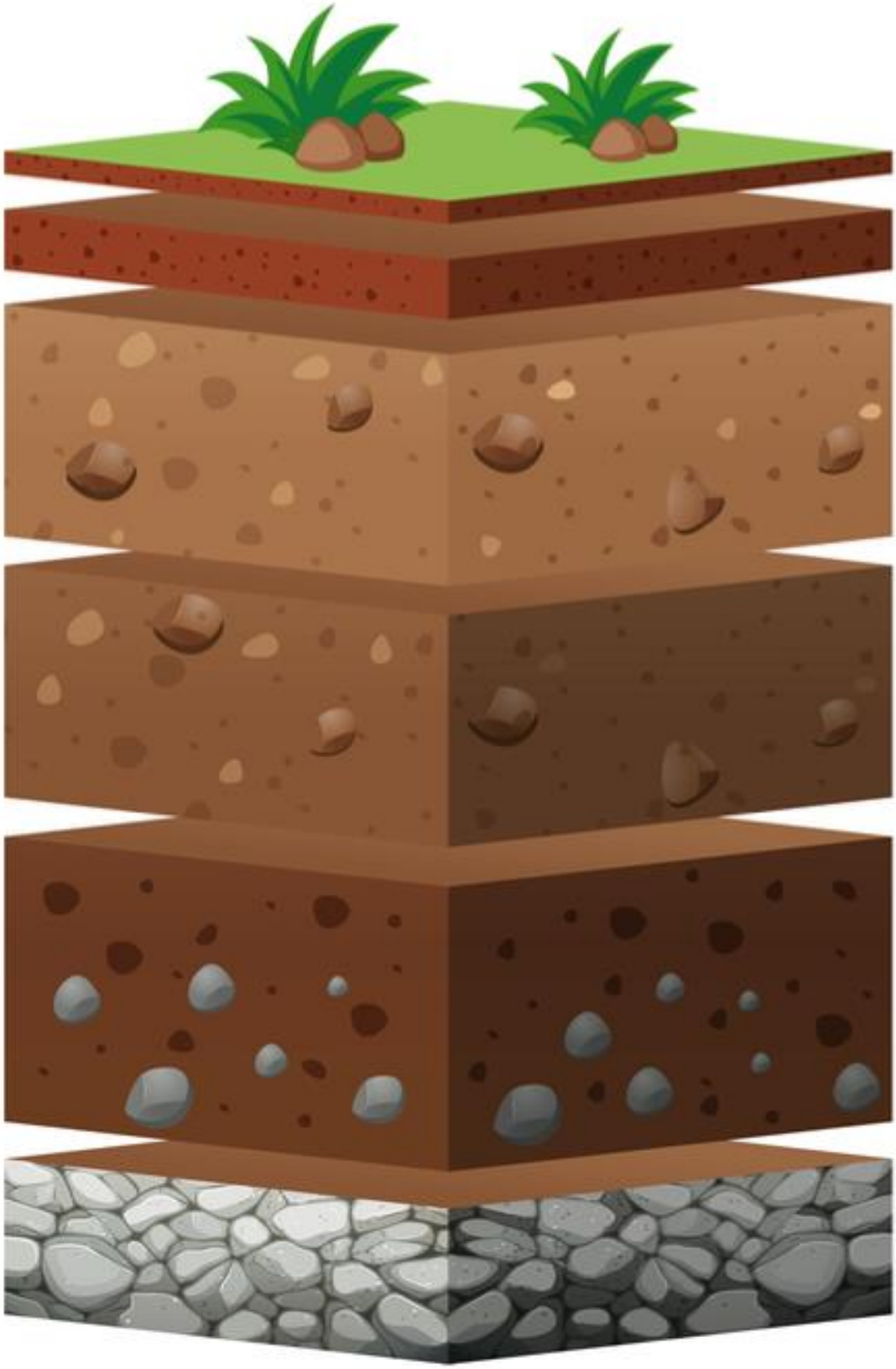
Soil profile station 1



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Work sheet station 1

Worksheet Station 1: Soil horizons

Soil horizon	short description	Properties/characteristics
O-Horizon		
A-Horizon		
B-Horizon		
C-Horizon		

What are soil categories?

_____

_____

What are soil types?

_____

_____

What is a soil profile?

_____

_____

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Information cards station 2

Soil erosion Refers to the removal of soil by water or wind that exceeds natural erosion processes. Soil erosion is exacerbated by human activities such as deforestation, destruction of vegetation cover through overgrazing and intensive farming. However, soil erosion is also influenced by natural factors such as surface forms, natural vegetation, climate, and the amount and intensity of precipitation.	Soil degradation Over the past 30 years, around 30 percent of the world's land surface has been damaged to such an extent that it can no longer fulfil its ecological and economic functions, or can only do so to a limited extent. This process is known as soil degradation. The main causes of soil degradation are wind erosion, water erosion, salinisation and waterlogging.
Soil compaction A reduction in the amount of voids in the soil is referred to as soil compaction. This occurs through the displacement and accumulation of soil particles or through pressure from heavy machinery on arable land. Rainfall no longer seeps away completely, and the space, aeration and water supply for soil organisms and plant roots are reduced.	Soil acidification A process in which the pH value of the soil decreases due to the leaching of hydrogen ions. Soil acidification is accelerated by agricultural use. Regular fertilisation with chalk can counteract acidification.
Soil sealing Refers to the covering or sealing of the soil in residential areas, traffic areas, and areas used for industrial and agricultural purposes. The soil is covered in an airtight and watertight manner, preventing rainwater from seeping away or making it difficult for it to do so. This also inhibits the exchange of gases between the soil and the atmosphere.	During the process of soil salinisation, salts accumulate in the topsoil, which can have very negative consequences for plants and the environment. Especially in dry areas where fields and plants have to be artificially irrigated, soil salinisation occurs quickly. There are various causes of salinisation, but in about 10% of the total salinised area of the earth, soil salinisation is due to human activity.

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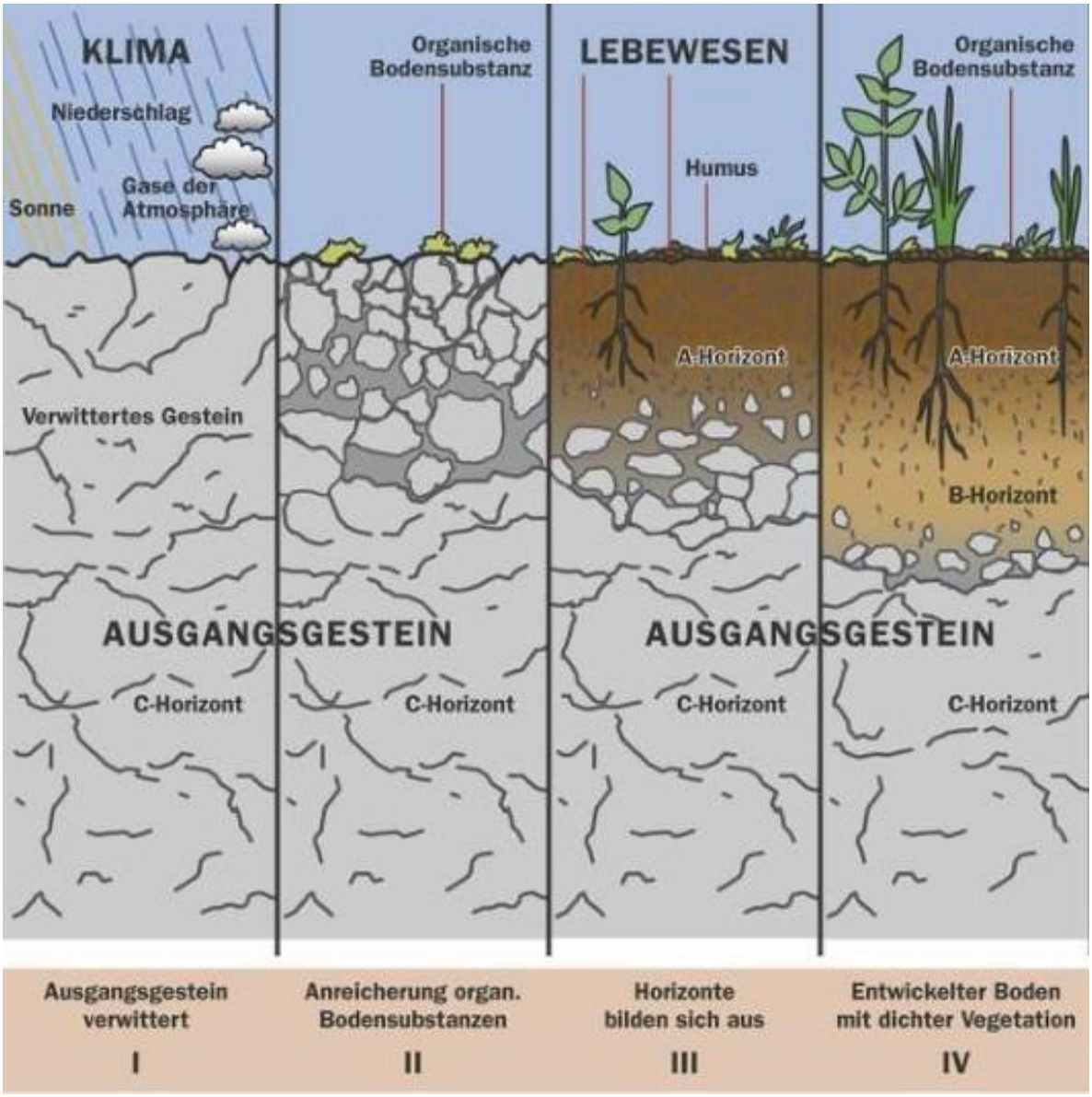
Image soil genesis station 4

Please search for a chart in your language



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Cloze text station 4

Cloze Text – Soil Formation

Physical weathering leads to the _____ of rocks. It results in the fragmentation of _____ along fractures, fissures, microcracks, and grain boundaries, whereby the rock is broken down into increasingly smaller _____. When rock bodies are gradually freed from the overlying rock masses through removal (= erosion), the pressure on them decreases and the rocks expand. This causes fractures and fissures to form, which is where the processes of physical weathering take place.

_____: This type of weathering is based on _____. Solid bodies usually expand when heated and contract when cooled. Rapid temperature changes cause the outer and inner parts of the rock to warm or cool at different rates. This creates _____ minerals. Granite, for example, breaks down more easily than basalt because it is made of dark and light minerals that heat up differently. Thermal weathering occurs particularly often where _____ change strongly and frequently, such as in desert areas and high mountain regions.

_____: The driving factor here is the _____ of freezing water by about 10%. Water entering rock fissures thus exerts a considerable blasting effect. Frost weathering is especially active in climates where the soil temperatures, along with abundant _____, frequently fluctuate around the _____, which is typical of many subpolar regions and high mountain areas.

_____ results in material changes of the rocks, for example when the rock is attacked by water, air, or various _____. In terms of chemical weathering, a distinction is made, for example, between so-called _____, where iron, manganese, and aluminum oxidize in the presence of _____, and solution or carbonic acid weathering. Here, salts and carbonates are removed from the rocks.

In _____, also called biogenic weathering, _____, _____, or _____destroy the rock. This happens, for example, through the growth pressure of plant roots (so-called _____): roots of trees force their way into rock fissures and break off chunks of rock through their thickening growth. Also, burrowing and digging _____contribute to the destruction of the rock. As a result, a loose material develops, from which soils are formed.

Terms (here in the nominative case): acids, biological weathering, temperature fluctuations, volume increase, freezing point, animals, animals, pressure differences, oxidation weathering, root expansion, oxygen, chemical weathering, thermal expansion, fragments, frost expansion, rocks, temperatures, mechanical destruction, plants, precipitation, microorganisms

Solution words in the correct order: mechanical destruction, rocks, fragments, thermal expansion, temperature changes, pressure differences, temperatures, frost expansion, volume increase, precipitation, freezing point, chemical weathering, acids, oxidation weathering, oxygen, biological weathering, microorganisms, plants, animals, root expansion, animals

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One minute paper

One minute paper
Procedure
1. The students get three questions (e.g. as a sheet, as cards or digitally):
    What is an important realisation or insight that I am taking away with me today?
    What is still unclear for me or would be worth deepening?
    What is my personal take-home message?
→ Individual work (2-3 minutes):
Everyone writes silently and for themselves. Emphasis: It's not about "right or wrong", but about your own perspective.
→ Voluntary exchange (optional, 2-3 minutes):
Those who wish to do so read out their results or it is collected in bullet points (e.g. on the whiteboard or flipchart; alternatively: digitally via Mentimeter, Padlet or Moodle forum).
2. Teacher concludes with a short summary of the points mentioned or addresses common ambiguities (possibly with references to further literature or resources).

Example for the sheet:
 My most important insight today:
(What idea, information or experience do I take away for me personally?)

……

……

 What is still unclear or open for me?
(Is there something I didn’t fully understand yet?)

……

……

 My personal take-home message:
(A sentence I want to remember.)

……

……

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Introductory games

Speed dating

- Two rows of chairs are placed opposite each other
- the participants sit down on the chairs and start a conversation in pairs about predetermined topics
- There are two minutes per conversation, when a signal sounds, everyone moves one place to the right

Contents: What is your name? Where are you from? What connects you to the floor? Why are you here? What do you want to achieve with your participation?

Classic round of introductions

- Circle of chairs, each participant briefly introduces themselves
- What is your name? Where are you from? What connects you to the floor? Why are you here? What do you want to achieve by taking part?

Common ground triangle

- Participants form groups of three
- Write their names in the corners of a triangle on a flipchart
- Talk about their interests around the topic of soil
- Similarities between two people are written on the line connecting their names, similarities between three people are written in the centre of the triangle

Inpromptu networking

- Music plays and the participants walk around the room
- Music stops, the participants come together in pairs and talk for two minutes about a specific question, when the music starts again, everyone continues to walk around

1. where are you from and why are you taking part in this module?
2. what interests you most about soil?
3. what do we need to consider in our group in order to make real progress on the topic of soil health?

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Feedback methods

Post it method

The post-it method is a brainstorming and ordering process for developing and visually presenting topics, ideas or prior knowledge. Post-it notes form the basis for collecting one's own thoughts and are then used to create a structured "carpet of terms".

Based on a specific question or topic, participants are asked to write their thoughts and ideas on these post-it notes without exchanging ideas with each other, with only one idea per piece of paper. These are then arranged on a suitable wall.

Gummy bear feedback

Each participant will receive a small bag of gummy bears. In turn, they are allowed to open their bags and look at the contents. Depending on the content, feedback must be given on the following categories:

Red: I liked that...

Green: That's what I've learned...

Yellow: That has remained unclear to me...

White: That's what I plan to do after the summer camp... (does not necessarily have to be covered by the ground)

Orange: I would like to say that...

Aha wall

To carry out the survey, participants need moderation cards or a sheet of paper. In the digital world, it makes sense to collect the aha moments in a padlet (padlet.com).

The participants are supposed to capture their aha moments. In an aha moment, for example, they have learned something new, found an explanation particularly helpful or discovered a reference to everyday life. The aha moments can be collected on a partition wall, so that the participants can better visualize their successes.

Target plate method

A circle with rings (similar to a dartboard) is drawn on a flipchart, which specifies six to eight topics (but there can also be fewer). Possible topics are, for example: learning success, working atmosphere, content, methodological design, individual support for learners, choice of excursions, etc.

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The topics are written along the circle on the flipchart, the circle contains four to five evaluation levels. Participants will receive one sticky dot (can also be implemented with pens) per topic area. The closer the points are to the center of the target, the more satisfied the participants are with regard to the respective topic area. The further out the points are, the less satisfied they are. Afterwards, a moderated discussion about the results can take place in the group.

Five-finger feedback

Little Finger: I didn't get enough ... Too little editing has been done ...

Ringfinger: I'm satisfied with ... Good was...

Middle finger: I didn't like it at all ... More emphasis should be placed on ...

Index finger: I received this hint ... A good idea was...

Thumb: I thought it was good ... Great thing...

Flashlight

This method is used to capture mood, opinions, and the state of content and relationships in a group. Participants express themselves on a certain topic in fixed and very short periods of time. Statements remain uncommented and the feedback is not given

noted. Question: What is your most important soil insight of the day?

Evaluation landscape

In the evaluation landscape, the participants placed a dot on a part of the picture that symbolically expressed their assessment of learning success, for example. In other words, they associate their assessments with points on the landscape/image.

Examples: Point on the way to the top of a mountain can mean: I have a large increase in learning; Point on the shore: I finally have solid ground under me.

 (Sample images)

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Feedback poster

The feedback poster method is a way to get an overview of the opinion of an entire group.

To do this, write a question, various topics or the like on a large piece of paper and ask the group to leave their feedback according to the task. From simple feedback topics to concrete short impulses, everything can be noted on it – depending on the design of the task. Participants can either write directly on the poster or write down their comment on small cards and stick it on the poster.

Example topics/questions: What did you learn during the excursion? How has your perception of the soil evolved today?

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