IYS Soils Activity

Soil Science Society of America

What is Soil, and Why Study It?

Summary

This exercise aims to introduce students to soils, specifically the concept of soils as natural bodies, and t heir scientific study. A Socratic-seminar style discussion will be framed by several questions and visual aids provided by the instructor. These questions are intended to spur students to consider soils as a component of the natural world, and consequently the rationale and challenges to its study by drawing on history of soil science, thought experiments, and examples of the relevance of soils to human well-being and the greater ecosystems of which human societies are part.

Learning Objectives/ Outcomes

1. Students will be able to state how soils are a natural component of the natural world.
2. Students will be able to describe at least three reasons why soils are relevance to human well-being.
3. Students will be able to explain how many scientific fields evolved over time.

   On this last point, the proposed lesson plan has great potential to be incorporated into philosphy/history of science classes to demonstrate how science has responded to the demands of human societies to meet 'real' needs, either material and/or knowledge.

Key Words

pedogenesis, genetic classification, soil taxonomy, paradigm shift

Materials (per student, group etc.)

- Three 100 g soil samples, with differences

For background/supplementary reading:

- [more technical piece] "Historical development of key concepts in pedology" by J. Bockheim (University of Wisconsin): http://www.envsci.rutgers.edu/~gimenez/SoilsandWater08/Homeworks/Bockheim.pdf
- "History, Philosophy and Sociology of Soil Science" by Eric Brevik (Dickinson State University): http://www.eolss.net/Sample-Chapters/C10/E1-05A-41-00.pdf
- "A Brief History of Soil Science" by Eric Brevik: http://www.eolss.net/Sample-Chapters/C19/E1-05-07-01.pdf
- SSSA compilation of online resources for soil science history: https://www.soils.org/about-society/committees/S205.1

Ages of Audience

1. High School
2. College

Recommended group size?

Less than 20 (to facilitate discussion)

Where could you offer this?

1. Local school
2. Library

What type of room do you need?

1. Classroom seating
2. Outdoors

Type of Lesson (may be more than one)

1. Small group exercise/discussion critical thinking
2. Indoor
3. Demonstration (instructor or invited scientist use of props)

Time Needed

1. Teacher/Scientist prep time + clean up time < 5 min
2. Participant/class time = 30-60 minutes (flexible, discussion length determined as needed by teacher)

Method & Questions for Guiding Discussion

Arrange students in circle or semi-circle to facilitate seminar-style discussion. Below are three 'phases' for discussion, with accompanying questions that the instructor introduces to stimulate and moderate discussion.

PHASE 1—WHY CONSIDER SOILS?

- [Have students write down how they would define soils]
- How deep do soils go? How do you know? How far have you dug? Are all soils the same? What do you mean by "the same"?
- Does it make sense to say that we 'use' soils?
  - What are its uses?
  - How do these uses influence the definition you [the student] wrote at the beginning?

PHASE 2—HISTORY OF SOIL SCIENCE: HOW HAVE OTHERS LOOKED AT SOILS, AND WHY?

- Soils classified by different cultures in different ways
  - Field of *ethnopedology* (analogous to ethnobotany, ethnomusicology)
- Agricultural-centric classification and understanding of soils
- Other soil relevance:
  - Mining
  - Construction (e.g. brick materials, foundations)
  - Religious (origin myths; burials)
- "Pedology"- from Greek *pedon* (soil) + *logos* (study)
  - Coined in 1862 (concurrent with scientific revolutions in chemistry- strong crossover between agricultural chemistry and chemistry)
  - Chemical reductionist approaches

continued...

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- Genetic soil science
  - Vasili Dokuchaev developed the fundamentals of soil investigation: soils are natural bodies that reflect the specific characteristics of the environment in which they are formed
    - Darwin described soil genesis
    - Are there similarities between Darwin's Theory of Evolution and the dynamic notion of soils as formed (and forming) natural bodies in response to their environment?
  - Hans Jenny's conceptual equation $S = f(cl, o, r, p, t, ...)$, where soil (S) is a function of climate (cl), organisms (o), relief or topography (r), parent material (p), time (t), and unspecified factors (...)
    - Where would humans fit in?

PHASE 3—SOILS ARE NATURAL BODIES

- Soils are three-dimensional natural bodies
  - Mixture of mineral and organic matter
  - Differences in their characteristics (morphology) are important to understand how they formed what their properties are, and thus how they might be used
    - Knowing what you know about the "soils are natural bodies" and pedogensis, is potting soil 'soil'?
- Continuing the organism analogy, how might you classify soils?
  - Different taxonomic systems, with a diversity of purposes and scientific vs. empirical bases (ethnopedology)
  - USDA Soil taxonomy—classifying soils to understand their genesis
- Vertical stratification: like rings on a tree, the horizontal layers (like a layer cake) of a soil reflect processes that have occurred over time during the formation of that soil
  - Soil scientists 'read' this code to understand soil and formation properties

PHASE 4—TO STUDY IT, YOU MUST DEFINE IT: HOW TO DEFINE SOILS?

- Background: There are different ways of defining soil
  - Biocentric: able to support life, or specifically, plant growth)
    - Legally speaking, the biocentric definition is more accepted than the geocentric definition. USDA requires importation permits for foreign soils, on the basis that these may harbor microbes or other forms of life that could be human, livestock, or crop pathogens. The destruction of the European wine industry in the 1800s via Phylloxera was due to transport of soil containing the pest from California to France.
  - Geocentric: amalgam of mineral and organic materials on Earth's surface, 'skin of the earth'
  - Ecocentric: As a matter of observation, we can at least say that soils are the basis of terrestrial systems.
  - What is, if any, the bias of this definition?
    - Soil is a natural body of mineral and organic matter that changes, or has changed, in response to climate, topography and organisms acting on parent material over time.
    - Note the dynamic (process-based) character of this definition
- Thought experiment: Consider the following:
  - Are there soils on the Moon? What about Mars? What about another (non-Earth) planet able to support life?
  - For bio-centric definitions, is it the potential to support life or actual support of life?
    - E.g., if we bring back 'soil' from Mars and we are able to grow it?
- The difficulty of a single definition of soil reflects its complexity as the intersection of different '-spheres': atmosphere-biosphere-geosphere

References

Brevik & Hartemink. 2010. Early soil knowledge and the birth and development of soil science *Catena* 83:23.

Hartemink. 2009. The depiction of soil profiles since the late 1700s. *Catena* 79:113.