Soils—Experimental and Field Investigation

Earth Science Extras
by Russ Colson

Assignment:

1) Collect at least two soils from different locations with different properties. These soils should be chosen to allow you to address a specific question. For example, how does sandy vs clay-rich soil affect <property of soil>? How does organic content affect <soil property>? How does long-term cultivation vs natural biome affect <soil property>?
2) Choose one particular property of the soil to investigate that might vary between the two (or more) soils sampled
3) Design an experiment to measure that property in the two soil samples. You will need to think about how to control for other variables that you need to hold constant, how to create an experiment that looks at that one variable in your different soil samples, and how to make measurements.
4) Create tables and/or graphs that clearly show your results
5) Interpret your results in terms of the original questions you asked, and in terms of the actual results that you got.
6) Write a report. Your report should identify your question and why it is important, explain your sampling method and experimental method, provide your complete results, and give your interpretations of those results along with clear reasoning for why you think those interpretations are correct given your experimental measurements.

NOTE: Expect that there will be unanticipated challenges and you will have to adjust your experimental plan to adapt. Solving unexpected problems is one of the main experimental skills that true investigation helps you practice.

Example properties you might measure:

Porosity of the soil, or its capacity to hold water. You will need to measure the amount of water that can be absorbed by the soil as a function of the total soil present (remembering that there might already be some unknown amount of water in the soil when you collect it.) -- example potential experimental problem: your sampling may disturb the soil significantly from its natural state, affecting the porosity.

Permeability of the soil, or its capacity to allow movement of water through it. You will need to measure how much water passes through a fixed thickness of soil under a constant pressure gradient, in a known amount of time. Example potential experimental problem: as with porosity, your sampling can affect the result, and how you 'pack' the soil for the experiment will have a huge effect of the result, probably a much bigger effect that the differences in your sampled soil.

Cation adsorption capacity: You will need to measure how the concentration of a cation (such as Na, Mg, or Ca) changes in water when the water passes through a set thickness of soil (or sits in the soil for some predetermined time). Example experimental challenge: You will need to find tools to measure the concentration of cations in water—there are methods/tools available for classroom and field use for measuring these parameters, also even materials for testing aquarium

water might work for you. Alternatively, and less meaningful, you could use a 'cation proxy' such as food coloring, and create a set of standards with known amount of food coloring to allow you to estimate how much food coloring is left in the water after passing through the soil.

Water retention capacity: You will need to measure how quickly and/or how much water will drain from or evaporate from a saturated soil sample under some set of conditions (such as humidity for evaporation or soil thickness and time for draining). Example experimental challenges: how will you measure how much water was present and what fraction of it drained or evaporated away?

Other property: ????????

Note 1: An investigation in science is always more challenging that being told information in the classroom, and often we have a lot more experience "learning facts" about science from a 'teacher' than actually doing science. However, the investigative activity presented in this lesson actually addresses a Minnesota state high school science benchmark and so is something you should already be able to do based on your high school science experience (yes, I know that investigation is an ongoing skill that is developed over a lifetime, not in one high school class activity—that's why you're getting another chance to do it here!)

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Minnesota High School Science Benchmark: 9E.1.2.1.2 Plan and conduct an investigation of the properties of soils to model the effects of human activity on soil resources. (P: 3, CC: 2, CI: ESS3, ETS2) Emphasis is on identifying variables to test, developing a workable experimental design, and identifying limitations of the data. Examples of variables may include soil type and composition (particularly those found in Minnesota), erosion rate, water infiltration rates, nutrient profiles, soil conservation practices, or specific crop requirements.

Note 2: In my example "walk through" experiment that you can look at after at least starting your own experiment, I am going to measure water retention capacity, and address the questions 1) how does sand/clay content affect water retention capacity and 2) how does land use (agriculture vs natural biome) affect water retention.

Note 3: Your report, including all the elements listed above, should be submitted in pdf format. Your report should additionally include pictures of your field sampling and experimental set up, and you must be seen and identifiable in at least one of the pictures.