It’s foundational - Soil is the key to Earth’s sustainability!

a presentation for
2025 NSTA Conference in Philadelphia
by

Clay Robinson, PhD
Wale Adewunmi, PhD
Melanie Szulczewski, PhD
James Montgomery, PhD
Missy Holzer, PhD

Workshop Outline

- Workshop Goals
- Introductions
- 4 Pillars of Sustainability
- The Trouble with the Lead Legacy
- Soil & Culture
- Soil & Water Quality
- Classroom Connections & Resources

Workshop Resources:
https://www.soils4teachers.org/nsta

Workshop Goals

Goal: Gain a deeper understanding of the impact of human activities on soil health, while reviewing the critical role of soil in the sustainability of our planet and incorporating the four pillars of sustainability: economic, social, environmental, and cultural.

Objectives:

- learn about the economic benefits of healthy soil, the social implications of soil degradation, the environmental importance of soil conservation, and the cultural significance of soil in different societies.
- identify instructional resources to support learning about the critical role of soils in the four pillar of sustainability.

Workshop Resources:
https://www.soils4teachers.org/nsta

KNOW SOIL KNOW LIFE

Introductions

Introductions

- Your team!
  - Clay Robinson, CRC Soil and Ecosystem Services, LLC
  - Wale Adewunmi, Binomial Associates, LLC
  - Melanie Szulczewski, University of Mary Washington
  - James Montgomery, DePaul University
  - Missy Holzer, SSSA K12 Committee Chair

Workshop Resources:
https://www.soils4teachers.org/nsta

Who's Joining Us Today?

Elementary School	5 years or less
Middle School	6-19 years
High School	20+ years
Higher Ed	
Informal Ed	

Workshop Resources:
https://www.soils4teachers.org/nsta

What do you know about your soil?

Define soil

What role does soil play where you live?

What do you know about your soil?

HAZLETON
Pennsylvania State Soil

SOIL SCIENCE SOCIETY OF AMERICA

Introduction

Many states have a designated state bird, flower, fish, tree, rock, etc. And, many states also have a state soil – one that has significance or is important to the state. The Hazleton is the official state soil of Pennsylvania. Let's explore how the Hazleton is important to Pennsylvania.

History

The selection of Hazleton as the official state soil began in 1995 when the Pennsylvania Association of Professional Soil Scientists (PAPSS) and the Pennsylvania Natural Resources Conservation Service (NRCS) collaborated on efforts to prepare for the National Soil Survey Centennial Celebration in 1999. Pennsylvania's Soil Survey Centennial was celebrated in 2000 based on the first soil survey published in 1900 for "The Lancaster Area". In order to increase awareness of our most important natural resource, many states developed plans to designate state soils as part of the centennial celebration.

The criteria for selecting a state soil included: The soil series must be named for a Pennsylvania location. The Hazleton was one of several other Pennsylvania soils considered including Berks, Gilpin and Penn soils. However, Hazleton was more extensive in total acreage (approximately 1.5 million acres) and in located in more counties (34 of the 67) mapped across the state. Hazleton was first characterized on the sandstone ridges and sideslopes near the city of Hazleton, Pennsylvania. Based on the selection criteria and review by the membership of the Pennsylvania Association of Professional Soil Scientists, the Hazleton soil series was recommended as the state soil for Pennsylvania in 1998. On April 21, 1999, Governor Tom Ridge signed a proclamation designating Hazleton as the state soil during Pennsylvania Soil Stewardship Week (**Figure 1**). The Hazleton soil has been promoted as the proclaimed state soil at the Farm Show, Ag Progress Days and other functions ever since this time.


Commonwealth of Pennsylvania

Governor's Office

Fig. 1. Hazleton Proclamation.
Credit:Commonwealth of Pennsylvania.

Photo Soil Monolith: Chip Clark/ Smithsonian Institution

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Workshop Resources:
https://www.soils4teachers.org/nsta

KNOW SOIL KNOW LIFE

4 Pillars of Sustainability

Soil Science Society of America
Soil Science Society of America · www.soils.org
www.soilsforteachers.org

USDA United States Department of Agriculture
Natural Resources Conservation Service

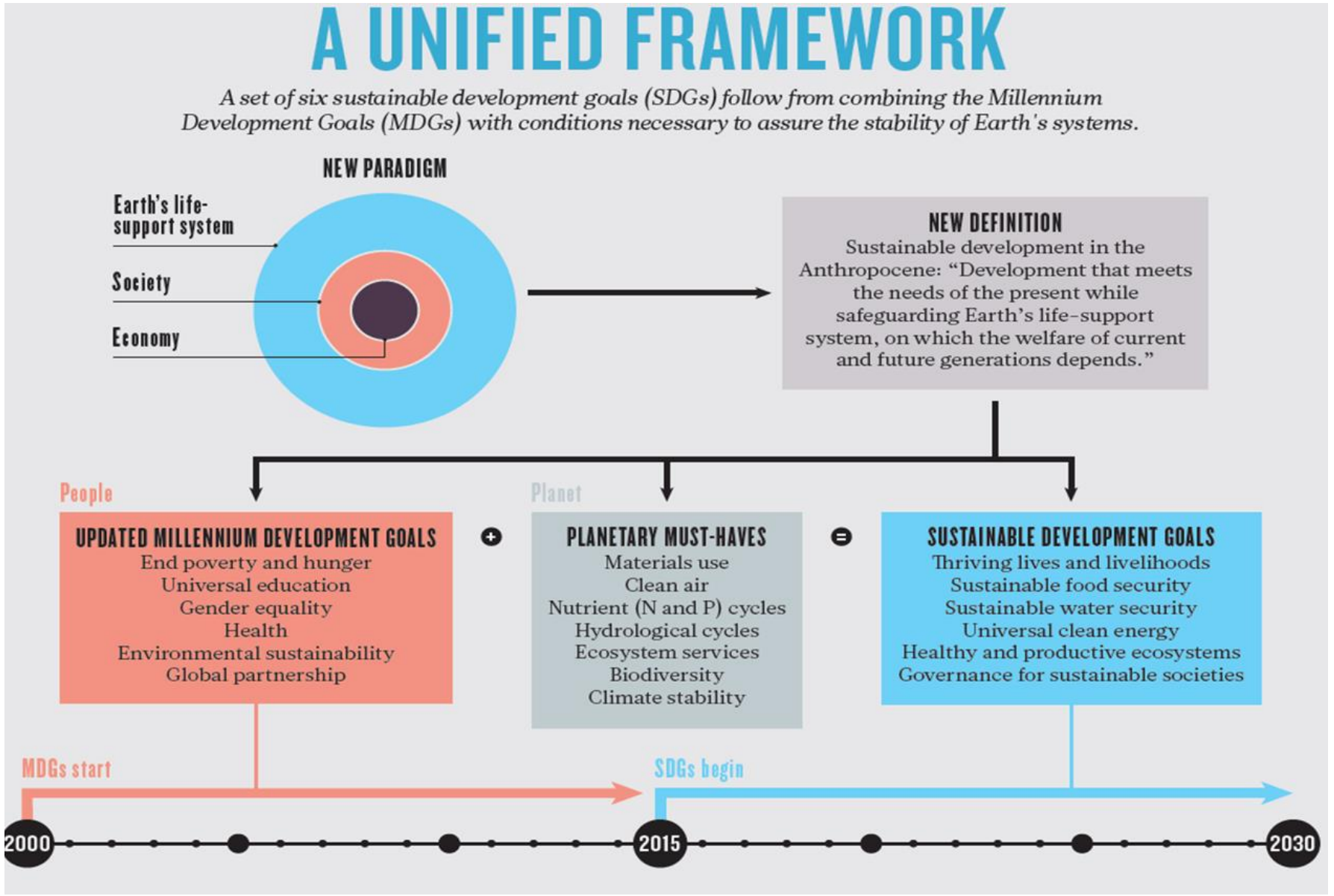
Definition of *Sustainability*

Humanity has the ability to make development sustainable –

to ensure that we meet the needs of the present without compromising the ability of future generations to meet their own needs

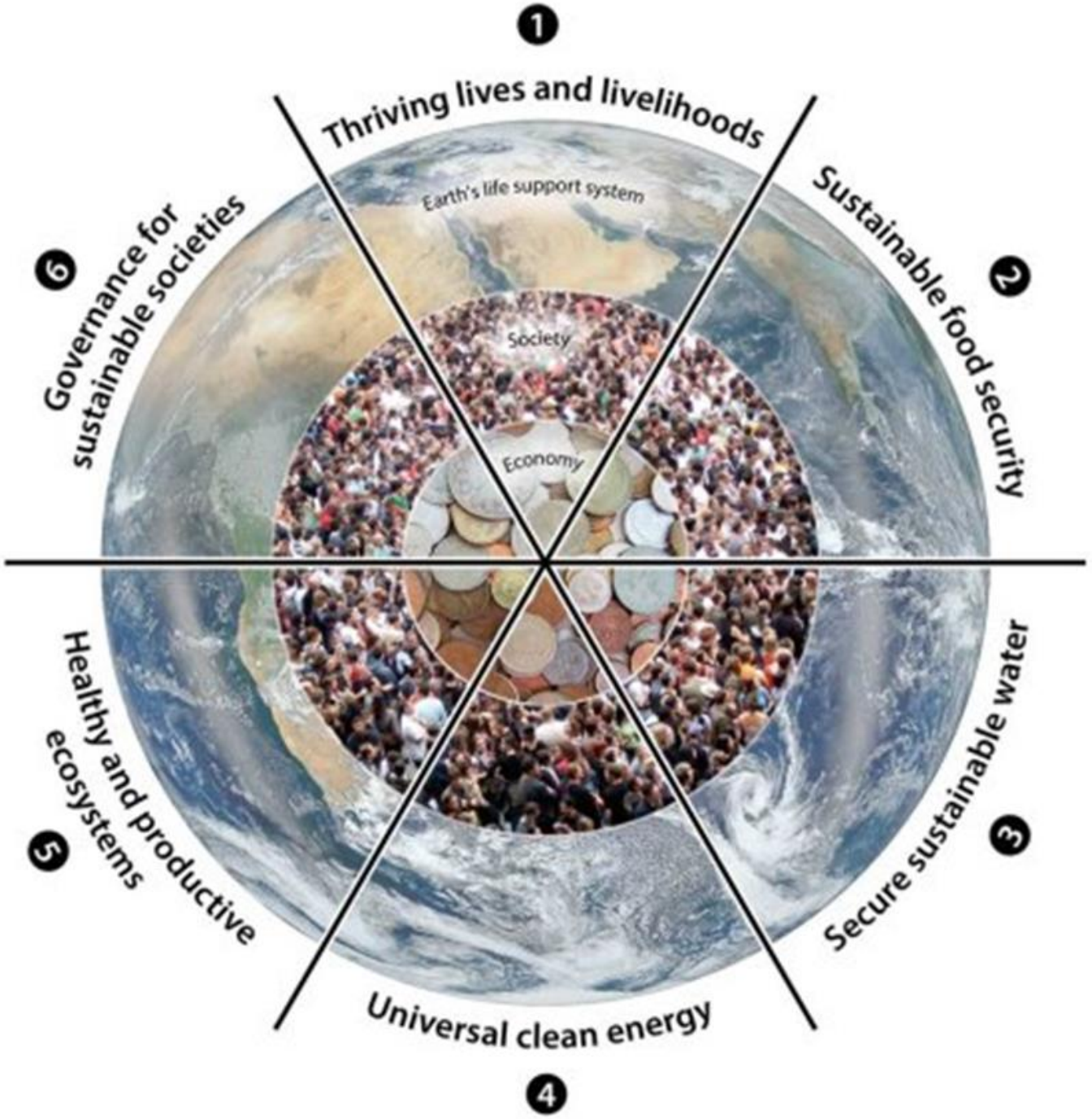
UN World Commission on Environment and Development, 1987

From the MDGs to the SDGs



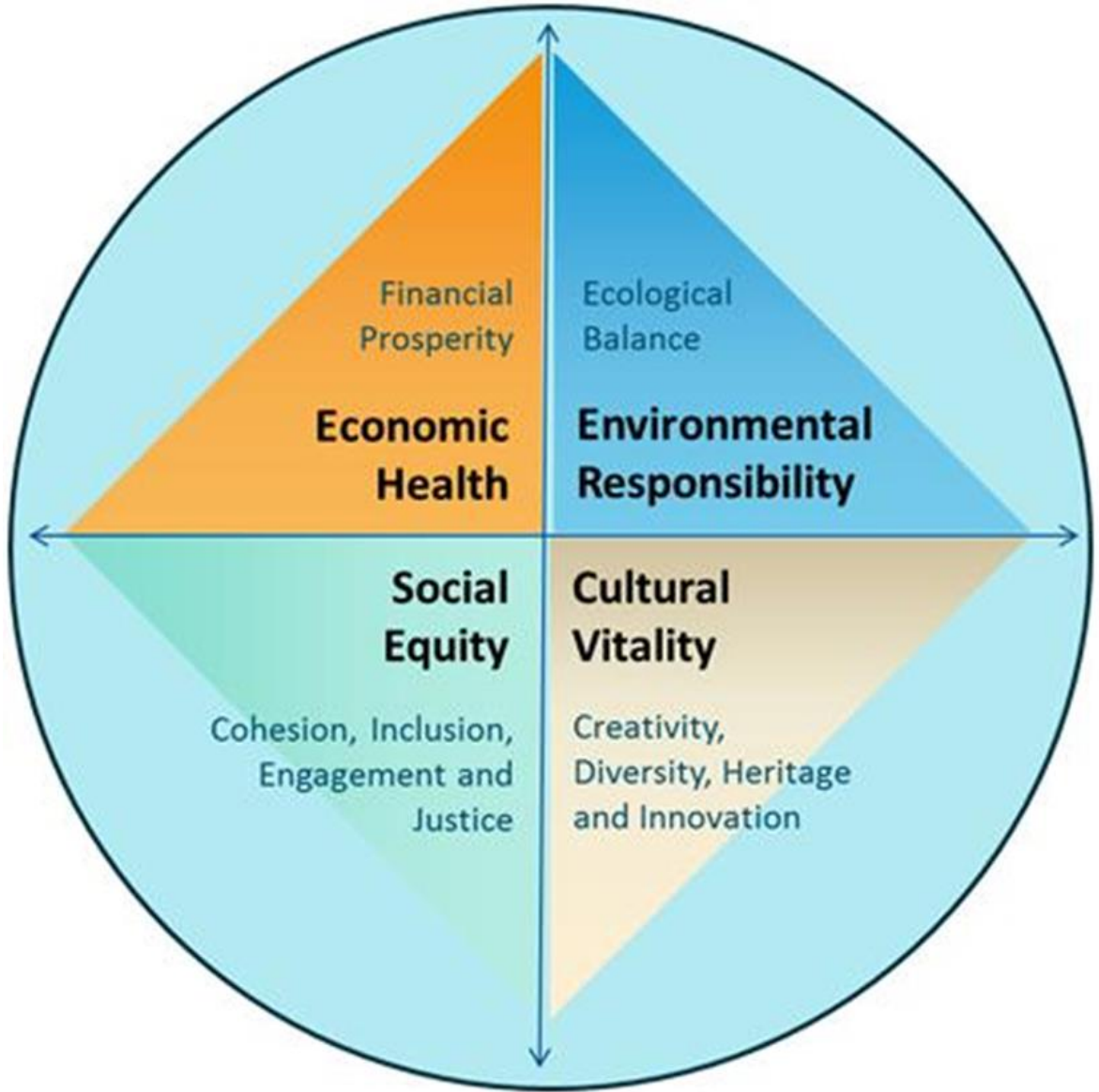
From Griggs et al., 2013

6 New Sustainable Development Goals



From IGBP

4 Pillars of Sustainability



KNOW SOIL KNOW LIFE

The Trouble with the Lead Legacy

Soil Science Society of America

USDA United States Department of Agriculture
Natural Resources Conservation Service

Lead's Many Uses

Today lead is used in

- Batteries
- Radiation shielding

In the past, lead was found in

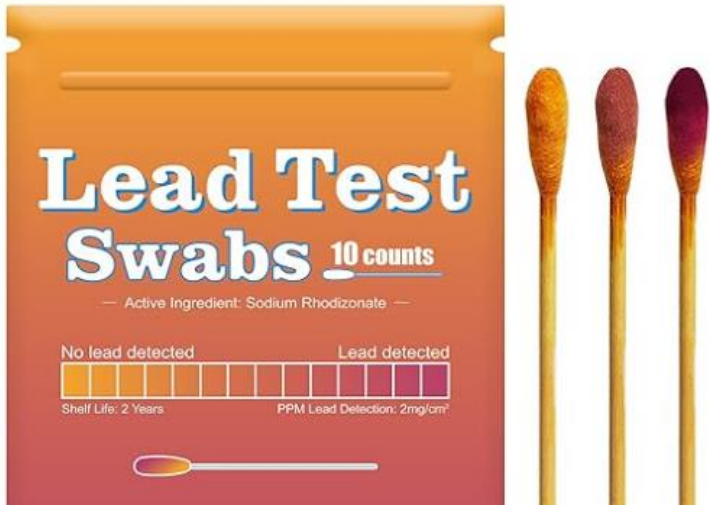
- Gasoline
- Paint
- Pipes
  - Fun fact: Lead's symbol is Pb fromthe Latin word for waterworks or plumbing - *plumbum*

Legacy (leftover) Pollution Impacts

Lead Testing

- Lead in drinking water
  - EPA action level is 15 ppb
  - EPA goal is 0 - there is no safe level of exposure
  - Use water test kit and follow enclosed instructions

- Lead in soil
  - EPA new (2024) residential limit is 200 ppm
  - Had been 400 ppm
  - California limit 80 ppm



Pillar Connections - Which Pillars did you identify?

Economic / Health

Environmental Responsibility

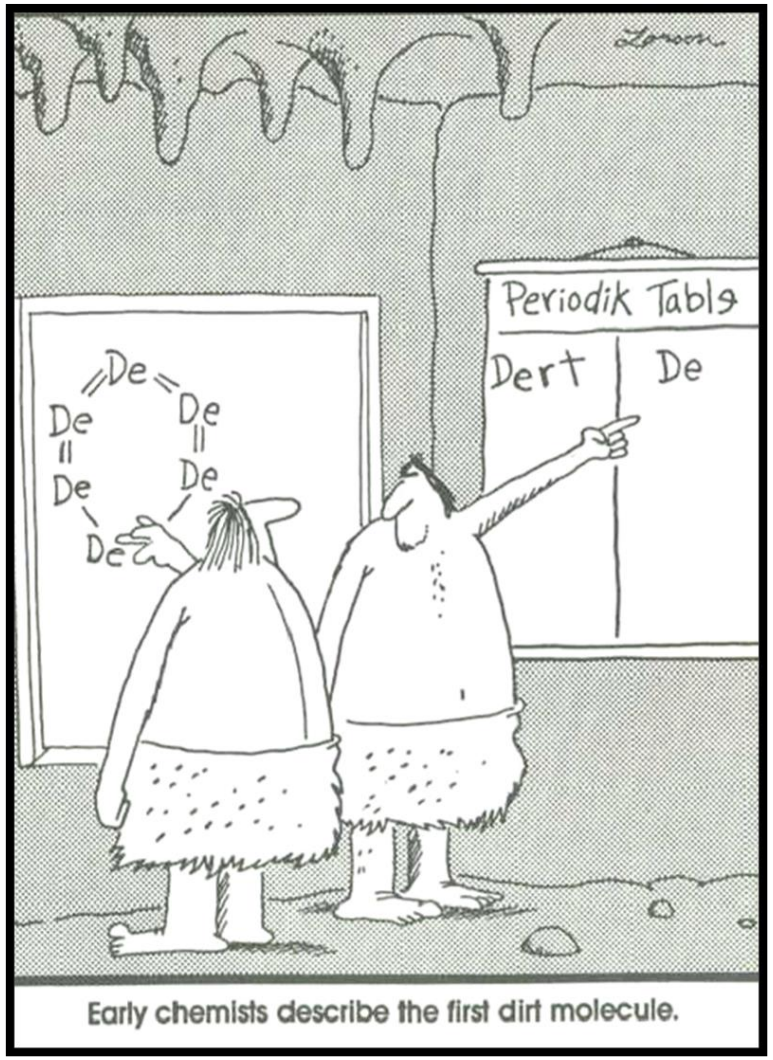
Social Equity

Cultural Vitality

KNOW SOIL KNOW LIFE

Soil and Culture

Soil and Culture



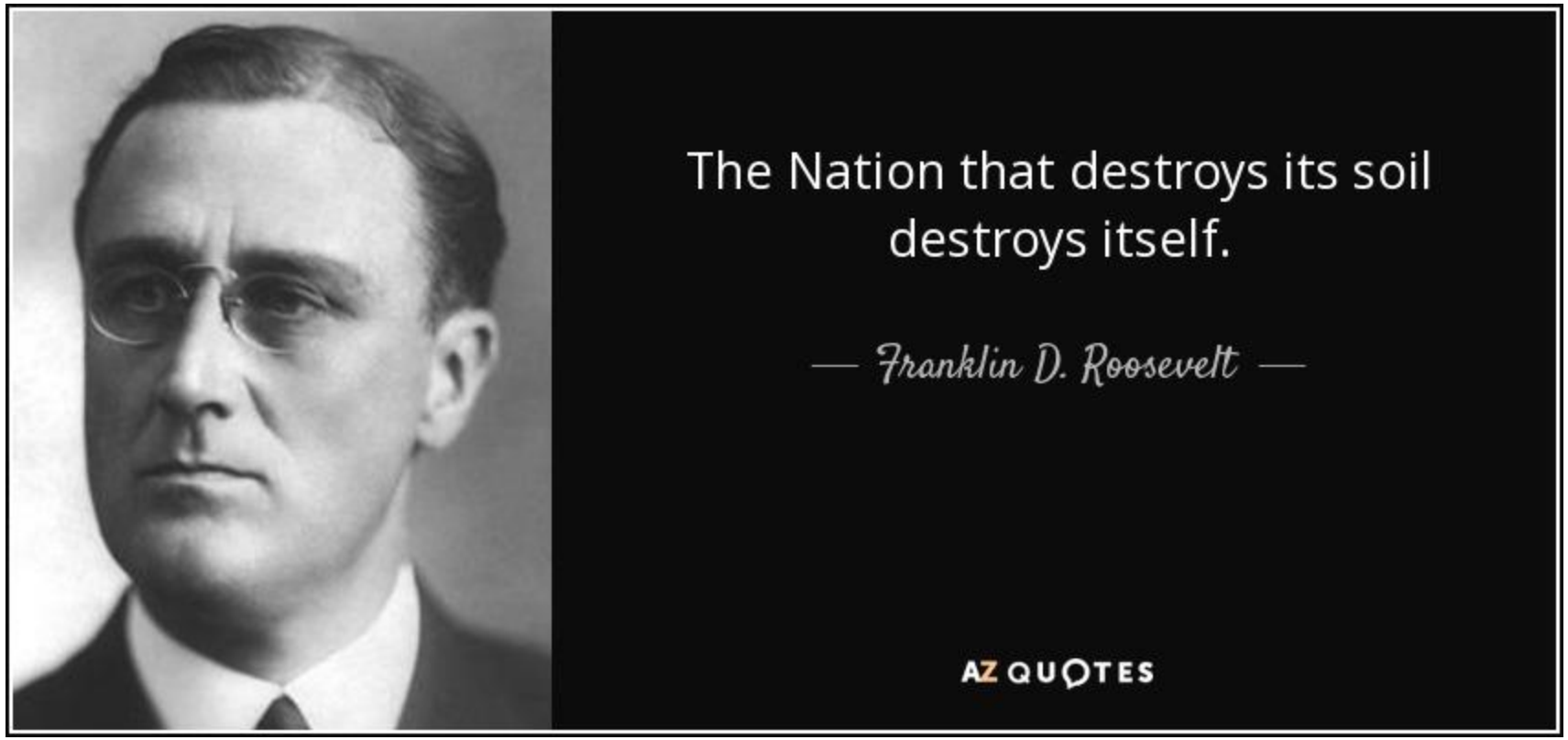
soils4teachers.org/KSKL

Does Soil

=

Dirt?

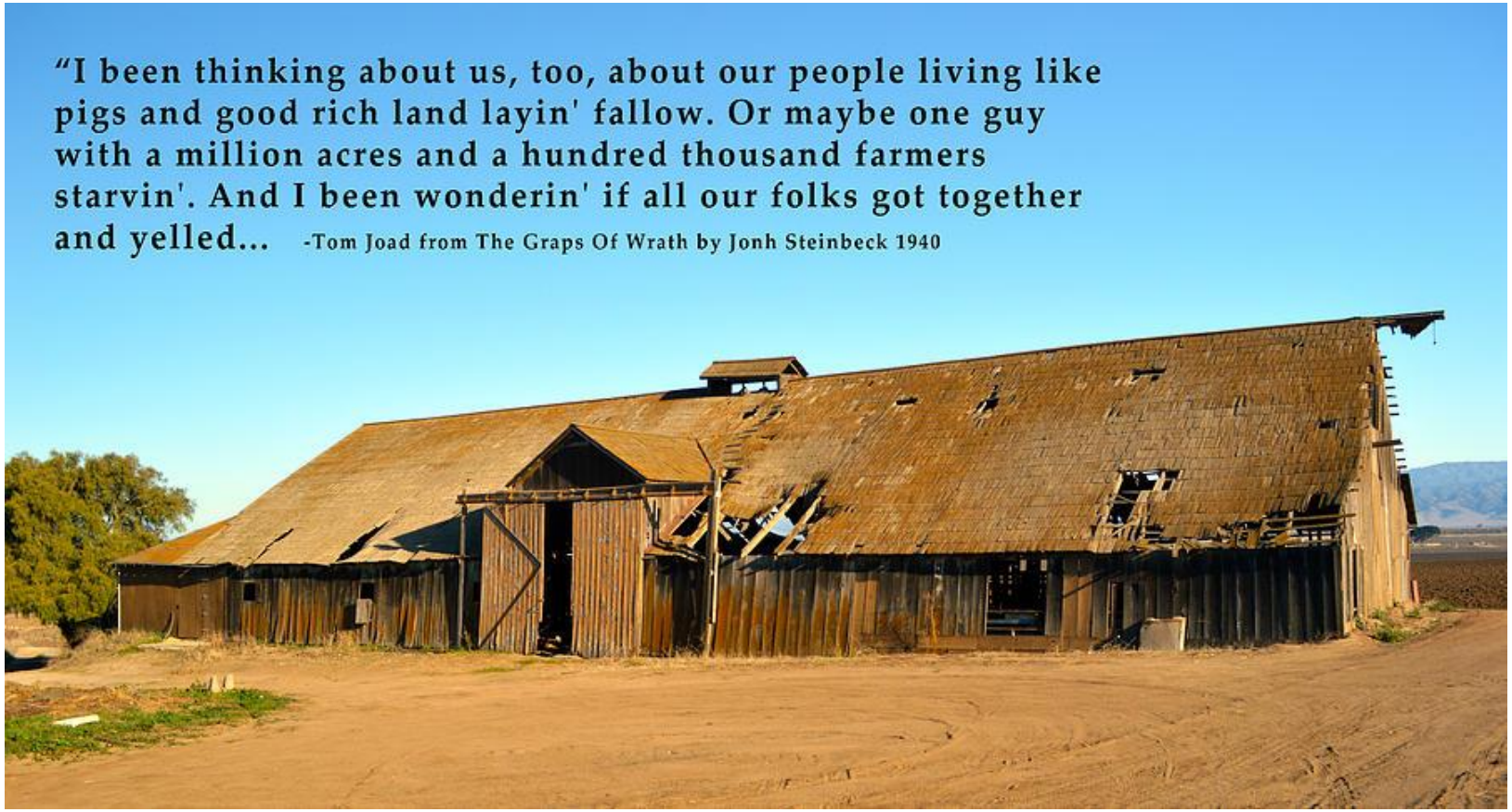
Soil and Culture



Think-Pair-Share: *What is the role of soil in human culture?*

Soil and Culture

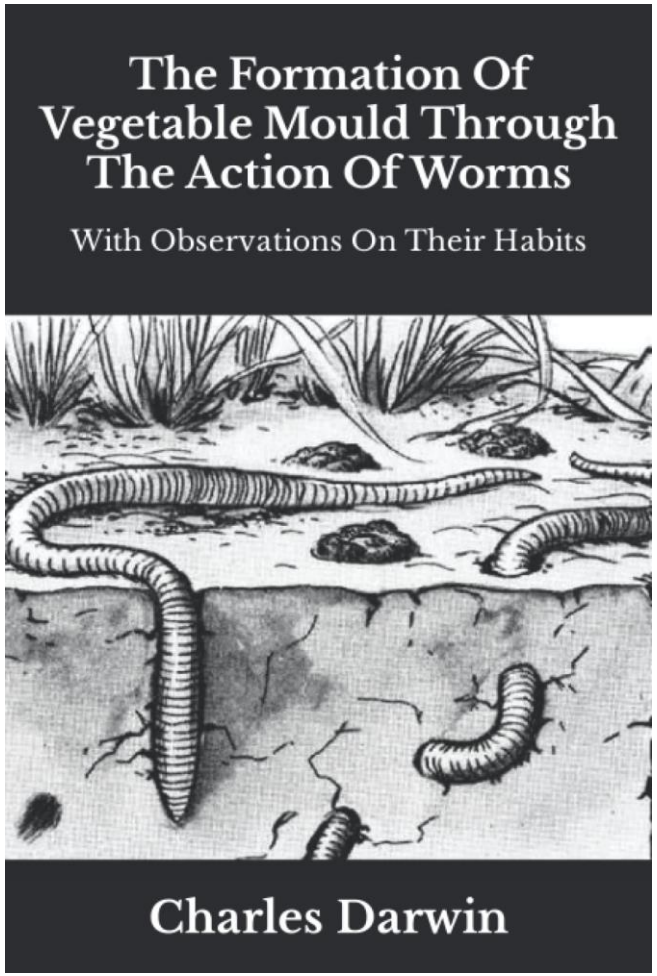
Soil and Literature



Credit: https://lvandcola.blogspot.com/2021/07/grapes-of-wrath-quotes-about-community.html

Soil and Culture

Soil and Literature



I was thus lead to conclude that all the vegetable mould [soil] over the whole country has passed many times through, and will again pass many times through, the intestinal canal of worms

C. Darwin

Soil and Culture

Soil and Music

"Dust in the Wind" - Kansas

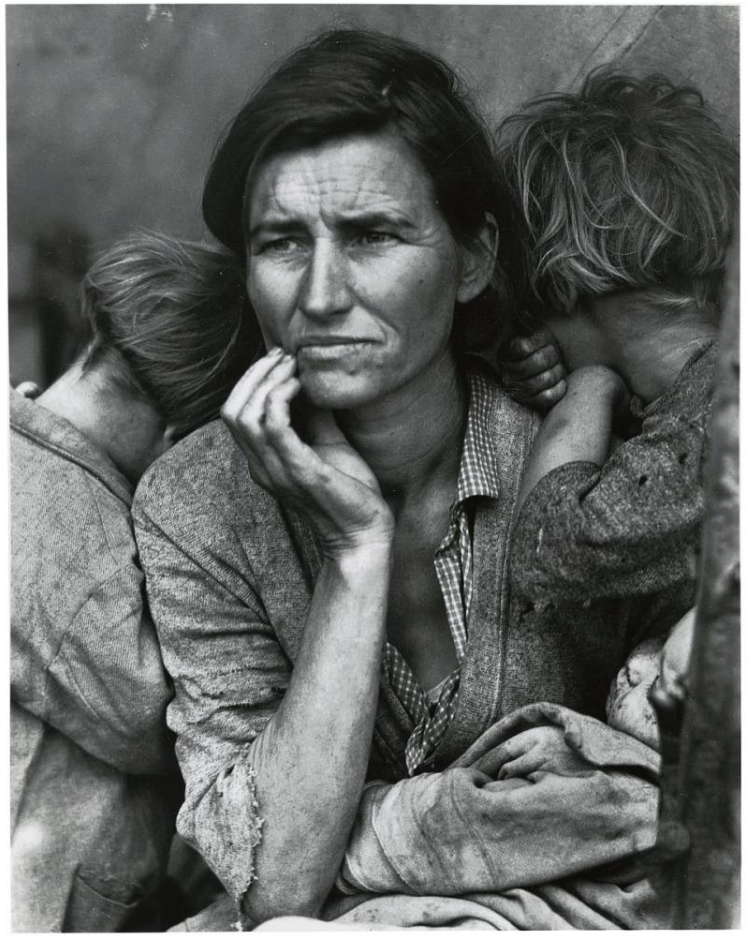
"All my dreams
Pass before my eyes, a curiosity
Dust in the wind,
All they are is dust in the wind"

Will Ferrell singing Dust in the Wind in the movie "Old School" (Photo Credit: Pinterest)

Soil and Culture

Soil and Art

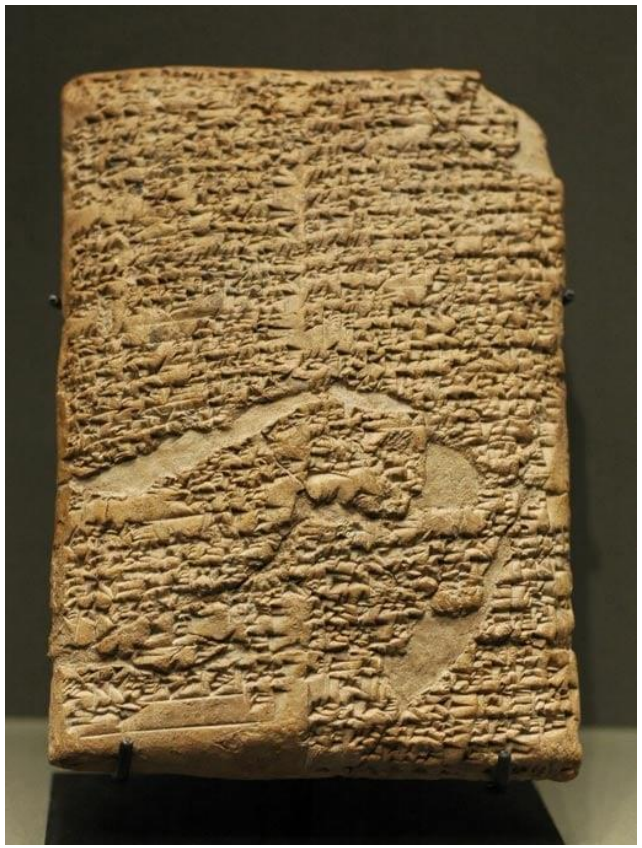
Credit: *Know Soil-Know Life*



Migrant Mother, Nipomo, California, by Dorothea Lange for FSA, 1936. Photo Credit: CC0; https://n2t.net/ark:/65665/ng49ca746ab-f81e-704b-e053-15f76fa0b4fa

Soil and Culture

Soil and Art



The Code of Hammurabi
Credit: The Louvre, Paris

Group Activity: Creating a Symbolic Language on a Clay Tablet

Directions: using the clay tablet and metal stamps, create a new symbolic language that represents some aspect of your STEM subject area.

Pillar Connections - Which Pillars did you identify?

Economic / Health

Environmental Responsibility

Social Equity

Cultural Vitality

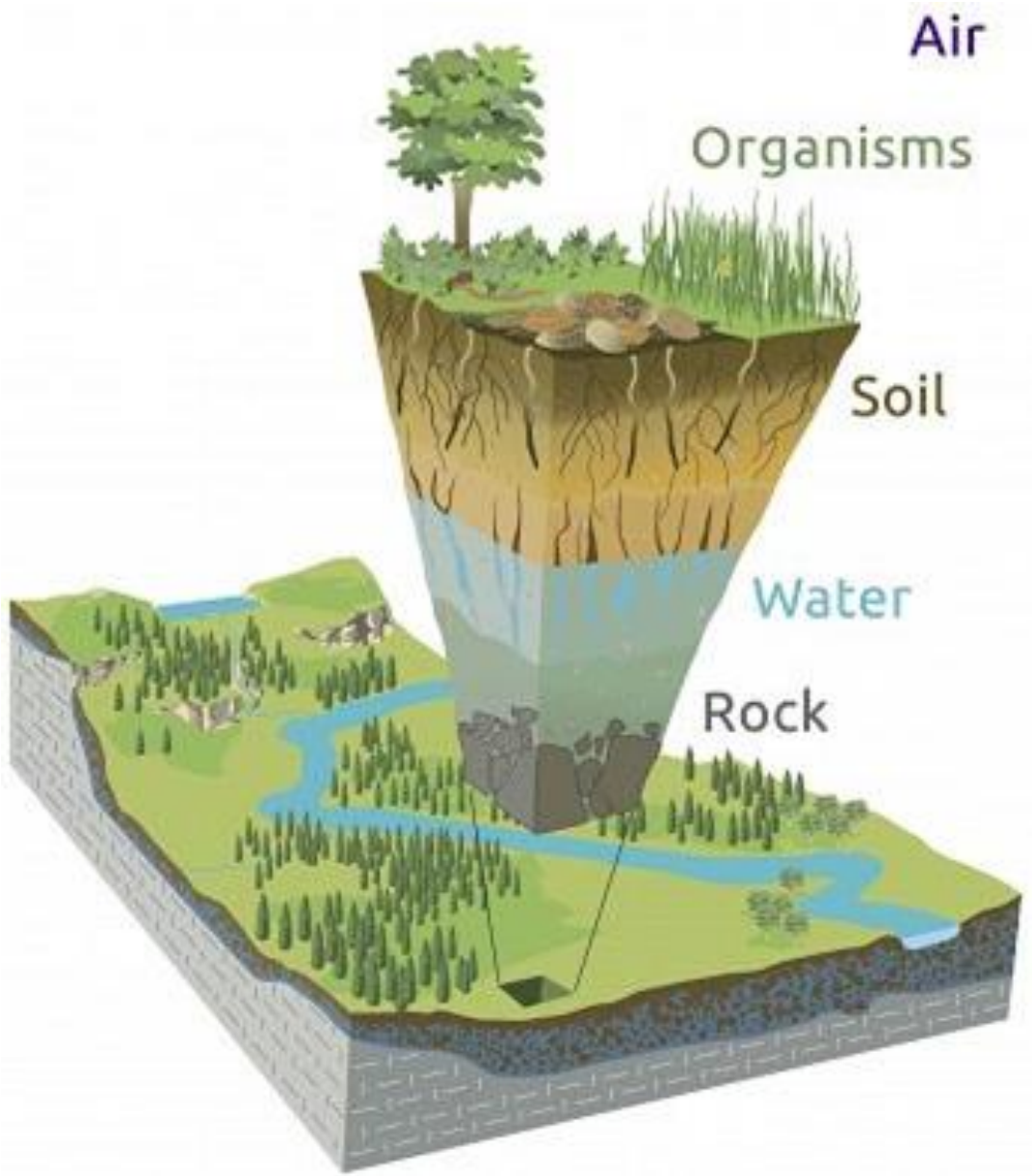
KNOW SOIL KNOW LIFE

Soil and Water Quality

Soil Science Society of America

USDA United States Department of Agriculture
Natural Resources Conservation Service

Environmental Sustainability

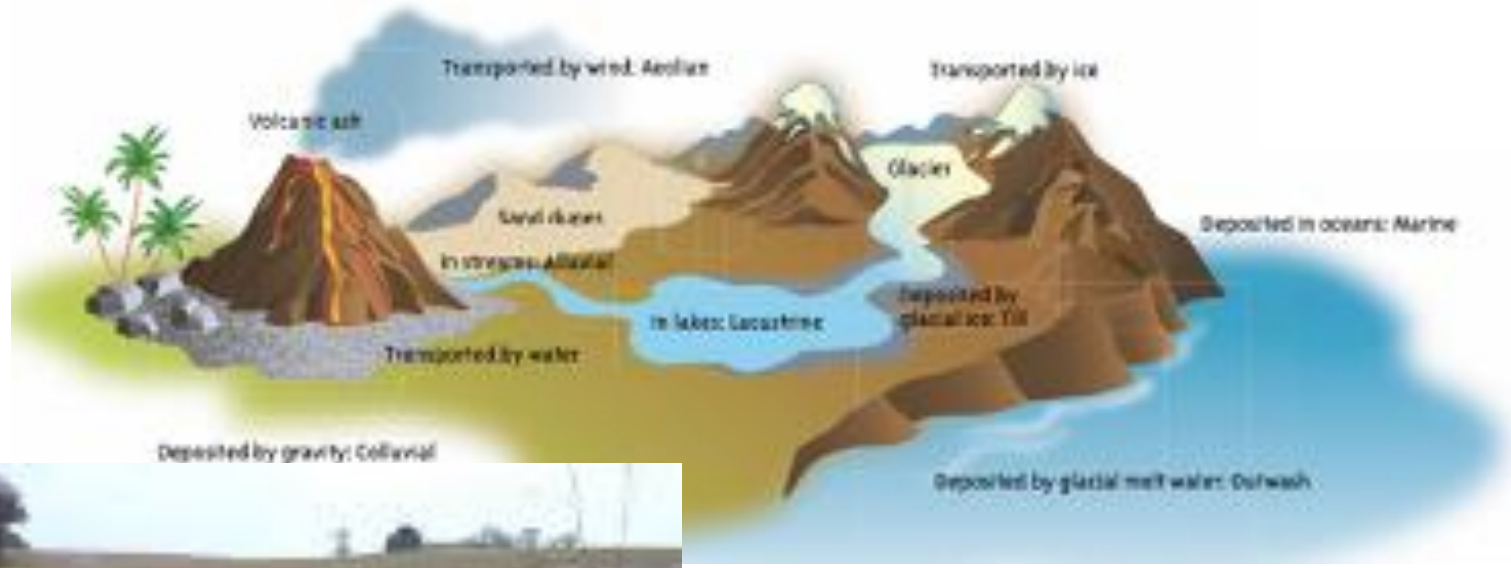


https://czo-archive.criticalzone.org/national/research/the-critical-zone-1national/

Protecting Soil - Naturally

In natural environment, the soil is covered by vegetation such as trees, forest litter and grass, and roots help hold the soil in place.

Soil and Water Quality: Erosion (& Leaching)



Erosion is when soil particles are

1. Detached
2. Transported
3. Deposited

Erosion shuffle https://www.youtube.com/watch?v=Vm16JCjxzvQ

How does soil affect water quality?

https://toppng.com/public/uploads/preview/question-mark-clipart-smiley-face-emoticon-thinki-11562854230bi1q5ej4ux.png
https://clipartix.com/wp-content/uploads/2016/08/Asking-probing-questions-clipart.jpg
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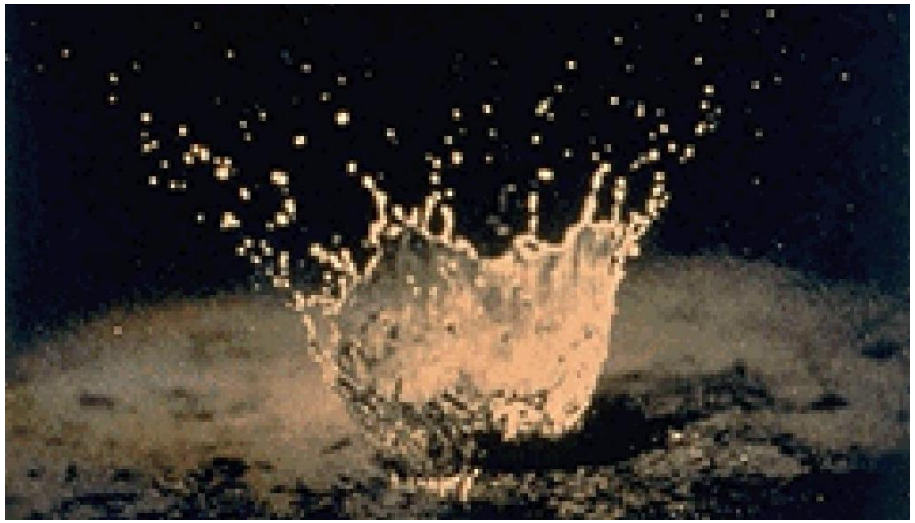
Soil and Water Quality: Erosion and Runoff



Water erosion carries –

- soil particles
- nutrients
- organic matter
- metals

https://www.sciencebuddies.org/Files/2393/5/EnvSci_img016.gif https://kj1bcdn.b-cdn.net/media/64560/fertilisers.jpg
https://miro.medium.com/v2/resize:fit:1080/1*oumh5WjhzzaTH4SdKPzuew.png
https://www.marinefinland.fi/download/noname/%7BEC8551CD-4172-4D83-85DC-2C0BE2B6FF99%7D/155059?maxwidth=1200&maxheight=10000

Soil and Water Quality: Water Erosion

Where did the soil go?

Soil and Water Quality: Water Erosion

Maybe here?

Soil and Water Quality: Runoff and leaching

Result of nutrient loading.

Protecting Soil in Agriculture

A tale of two farmers.

Which soil is protected?

Protecting Soil in Agriculture

Protecting Soil in Construction

Soil and Water Quality: Ground Cover

Vegetation is the best ground cover.

Erosion: Soil Lessons & Activities

IYS Soils Activity

Soil Science Society of America

Where Does All the Rainfall Go?

Summary

Participants will explore various factors that influence the amount of runoff that occurs when rain falls on the landscape by comparing the amount of runoff generated from a given area of bare soil, the same area with a portion covered by an impervious surface (simulating pavement, roofs, etc.), and the same area converted to a pervious area with a portion of the impervious area converted to a simulated "rain garden". The activity can easily to modified to explore the effects of slope, soil texture, antecedent moisture content, soil bulk density, the amount of impervious area, or soil cover (e.g., mulch, vegetation, erosion control fabrics) on runoff volume.

Learning Objectives/ Outcomes

1. To investigate the influence of impervious surfaces on runoff volume, which can be directly related to how urban and suburban development can greatly influence hydrology and the need for stormwater management.
2. To investigate how rain gardens can reduce runoff volume and be a critical part of stormwater management.
3. Related topics include the ability of soil or composts in rain gardens to clean water before it is eventually discharged into surface waters.
4. For computations, the runoff coefficient (runoff volume/rainfall volume) can be calculated.

Materials (per student, group etc.)

All materials are readily available in retail outlets. Substitutions are easy to make if necessary. This demo used three runs total, using a single pan that was refilled with fresh, dry soil prior to each run. Additional pans could be purchased to fill with soil in advance.

- Set of two foil disposable rectangular cake pans, 12 1/4 by 8 ½ by 1 3/32 inches. One pan is used to hold the soil and the other is used to capture runoff.
- 1000 mL measuring cup
- 3 pieces of 2 by 4 lumber, each 9 inches long
- Watering can, spray bottle, or sprayer
- Gridded template plastic (available where quilting supplies are sold), 12 × 18 inches
- Compost or small bag of potting soil. Less than 1 pound is required.
- Approximately 30-40 pounds of mineral soil (can use topsoil sold at a garden soil (40 lb bag) or collect local soil)
- Scissors
- Small binder clip
- Plastic spoon

Ages of Audience

1. Elementary
2. Middle School High School
3. Adults

Recommended group size?

20-50

Where could you offer this?

1. Local school
2. Any place with an audience that is interested in runoff or storm water management.

What type of room do you need?

Floor that can get wet and dirty, or outdoors on grass or cement.

Type of Lesson (may be more th

1. Hands-on (participants touch the
2. Outdoor
3. Indoor
4. Demonstration (scientist or tea demo, outside professional)
5. Experiment (follow procedur results, interpret results)

Time Needed

1. Scientist prep time = clea

Most of the prep time wi supplies. The actual se ment can be participat prep time is necessar depend on the locati on grass, no cleanup other than disposal runoff pans. If don indoors on a floor wet, minimal tim clean up spilled

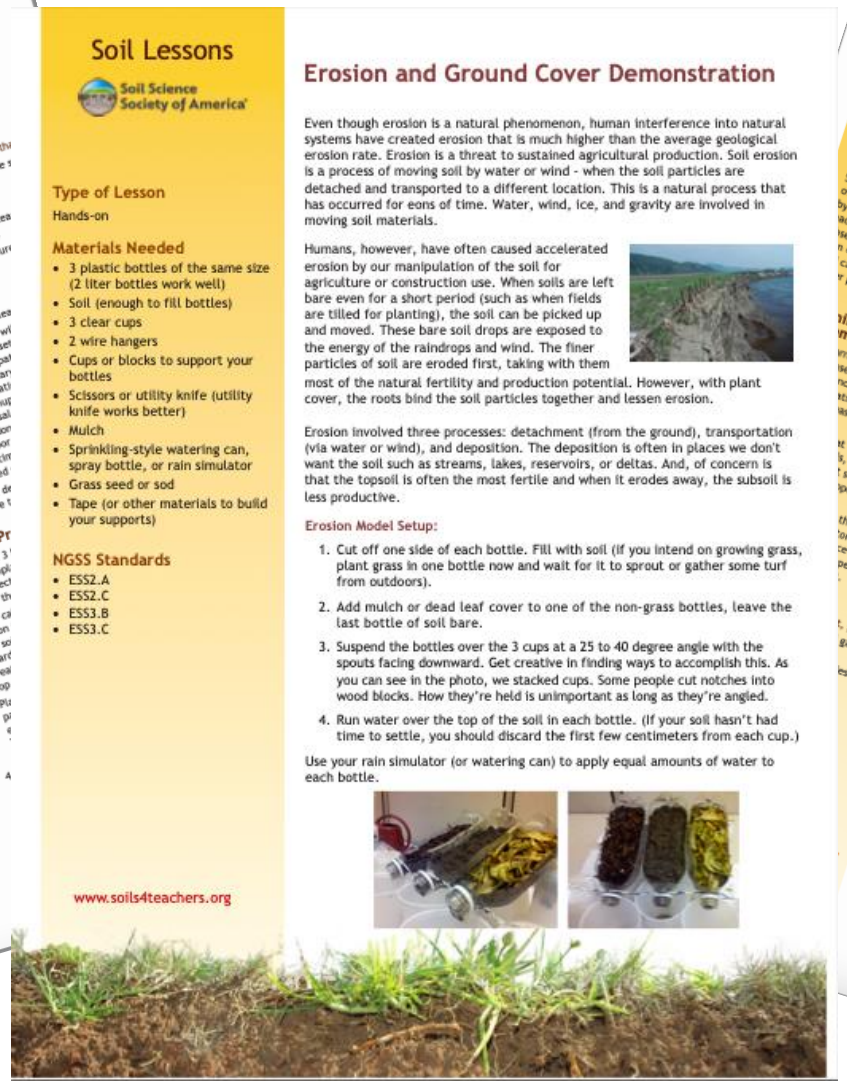
2. 30 to 60 min de variables are t

Methods/Pr

1. Cut two, 3 ded templ Cut a rec out of th
2. Fill a ca tap on the so board crea top
3. Pu pa

Celebrating the 2015 International Year of Soils

soils.org/IYS



Soil Lessons

Soil Science Society of America

Type of Lesson

Hands-on

Materials Needed

- 3 plastic bottles of the same size (2 liter bottles work well)
- Soil (enough to fill bottles)
- 3 clear cups
- 2 wire hangers
- Cups or blocks to support your bottles
- Scissors or utility knife (utility knife works better)
- Mulch
- Sprinkling-style watering can, spray bottle, or rain simulator
- Grass seed or sod
- Tape (or other materials to build your supports)

NGSS Standards

- ESS2.A
- ESS2.C
- ESS3.B
- ESS3.C

www.soils4teachers.org

Erosion and Ground Cover Demonstration

Even though erosion is a natural phenomenon, human interference into natural systems have created erosion that is much higher than the average geological erosion rate. Erosion is a threat to sustained agricultural production. Soil erosion is a process of moving soil by water or wind - when the soil particles are detached and transported to a different location. This is a natural process that has occurred for eons of time. Water, wind, ice, and gravity are involved in moving soil materials.

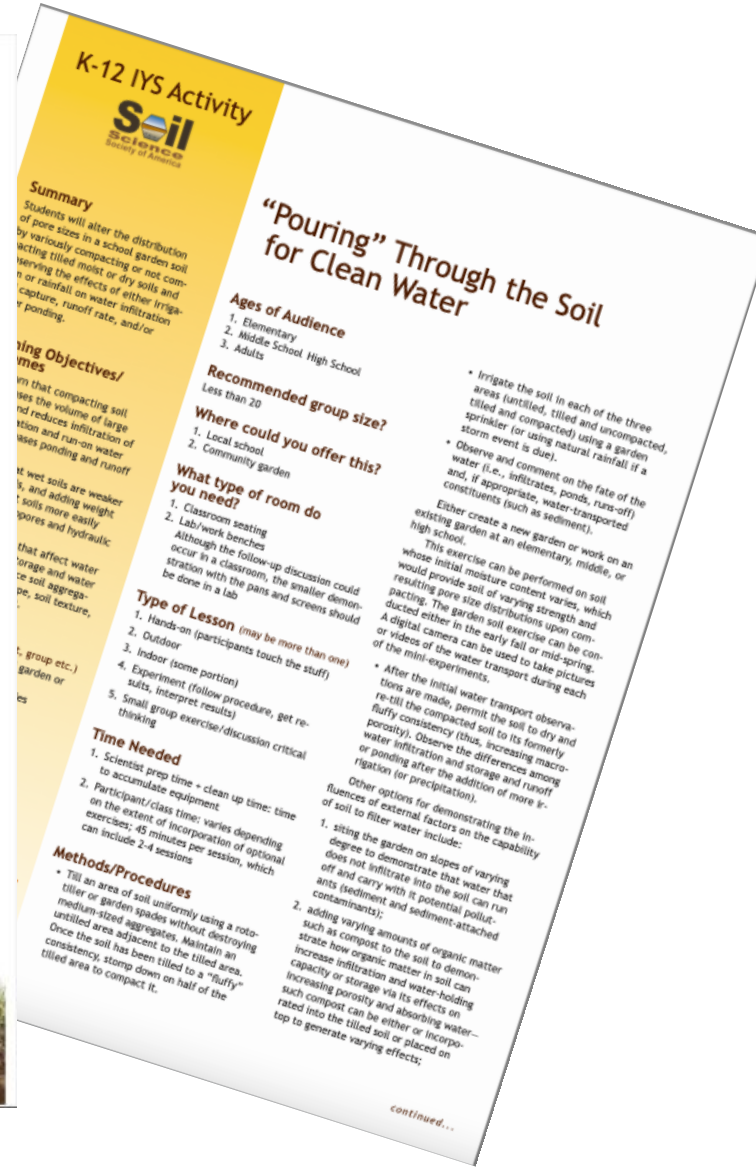
Humans, however, have often caused accelerated erosion by our manipulation of the soil for agriculture or construction use. When soils are left bare even for a short period (such as when fields are tilled for planting), the soil can be picked up and moved. These bare soil drops are exposed to the energy of the raindrops and wind. The finer particles of soil are eroded first, taking with them most of the natural fertility and production potential. However, with plant cover, the roots bind the soil particles together and lessen erosion.

Erosion involved three processes: detachment (from the ground), transportation (via water or wind), and deposition. The deposition is often in places we don't want the soil such as streams, lakes, reservoirs, or deltas. And, of concern is that the topsoil is often the most fertile and when it erodes away, the subsoil is less productive.

Erosion Model Setup:

1. Cut off one side of each bottle. Fill with soil (if you intend on growing grass, plant grass in one bottle now and wait for it to sprout or gather some turf from outdoors).
2. Add mulch or dead leaf cover to one of the non-grass bottles, leave the last bottle of soil bare.
3. Suspend the bottles over the 3 cups at a 25 to 40 degree angle with the spouts facing downward. Get creative in finding ways to accomplish this. As you can see in the photo, we stacked cups. Some people cut notches into wood blocks. How they're held is unimportant as long as they're angled.
4. Run water over the top of the soil in each bottle. (If your soil hasn't had time to settle, you should discard the first few centimeters from each cup.)

Use your rain simulator (or watering can) to apply equal amounts of water to each bottle.



K-12 IYS Activity

Soil Science Society of America

"Pouring" Through the Soil for Clean Water

Summary

Students will alter the distribution of pore sizes in a school garden soil by variously compacting or not compacting tilled moist or dry soils and observing the effects of either irrigation or rainfall on water infiltration capture, runoff rate, and/or ponding.

ing Objectives/ mes

m that compacting soil ses the volume of large nd reduces infiltration of tion and run-on water ases ponding and runoff

t wet soils are weaker s, and adding weight soils more easily pores and hydraulic

that affect water orage and water e soil aggrega- pe, soil texture,

, group etc.) garden or

es

Ages of Audience

1. Elementary
2. Middle School High School
3. Adults

Recommended group size?

Less than 20

Where could you offer this?

1. Local school
2. Community garden

What type of room do you need?

1. Classroom seating
2. Lab/work benches

Although the follow-up discussion could occur in a classroom, the smaller demonstration with the pans and screens should be done in a lab

Type of Lesson (may be more than one)

1. Hands-on (participants touch the stuff)
2. Outdoor
3. Indoor (some portion)
4. Experiment (follow procedure, get results, interpret results)
5. Small group exercise/discussion critical thinking

Time Needed

1. Scientist prep time = clean up time: time to accumulate equipment
2. Participant/class time: varies depending on the extent of incorporation of optional exercises; 45 minutes per session, which can include 1-4 sessions

Methods/Procedures

- Till an area of soil uniformly using a rototiller or garden spades without destroying medium-sized aggregates. Maintain an untilled area adjacent to the tilled area. Once the soil has been tilled to a "fluffy" consistency, stomp down on half of the tilled area to compact it.
- Irrigate the soil in each of the three areas (untilled, tilled and uncompacted, tilled and compacted) using a garden sprinkler (or using natural rainfall if a storm event is due).
- Observe and comment on the fate of the water (i.e., infiltrates, ponds, runs-off) and, if appropriate, water-transported constituents (such as sediment).

Either create a new garden or work on an existing garden at an elementary, middle, or high school.

This exercise can be performed on soil whose initial moisture content varies, which would provide soil of varying strength and resulting pore size distributions upon compacting. The garden soil exercise can be conducted either in the early fall or mid-spring. A digital camera can be used to take pictures or videos of the water transport during each of the mini-experiments.

- After the initial water transport observations are made, permit the soil to dry and re-till the compacted soil to its formerly fluffy consistency (thus, increasing macroporosity). Observe the differences among water infiltration and storage and runoff or ponding after the addition of more irrigation (or precipitation).

Other options for demonstrating the influences of external factors on the capability of soil to filter water include:

1. siting the garden on slopes of varying degree to demonstrate that water that does not infiltrate into the soil can run off and carry with it potential pollutants (sediment and sediment-attached contaminants);
2. adding varying amounts of organic matter such as compost to the soil to demonstrate how organic matter in soil can increase infiltration and water-holding capacity or storage via its effects on increasing porosity and absorbing water—such compost can be either or incorporated into the tilled soil or placed on top to generate varying effects;

continued...

https://www.soils4teachers.org/nsta/

Soil and Water Quality: Water Erosion Activity

Hands-on classroom activity demonstrating water erosion and quality of water.

https://www.soils.org/files/s4t/lessons/lessonplan-erosion-model.pdf

Soil and Water Quality

Where would you rather swim or fish?

Pillar Connections - Which Pillars did you identify?

Economic / Health

Environmental Responsibility

Social Equity

Cultural Vitality

KNOW SOIL KNOW LIFE

Classroom Connections and Resources

Soil Science Society of America

Soil Science Society of America · www.soils.org ·
www.soilsforteachers.org

USDA United States Department of Agriculture
Natural Resources Conservation Service

Introducing Soils 4 Teachers

www.soils4teachers.org

State Soil Booklets

New! State Soil Booklets

Learn the story of your state soil!

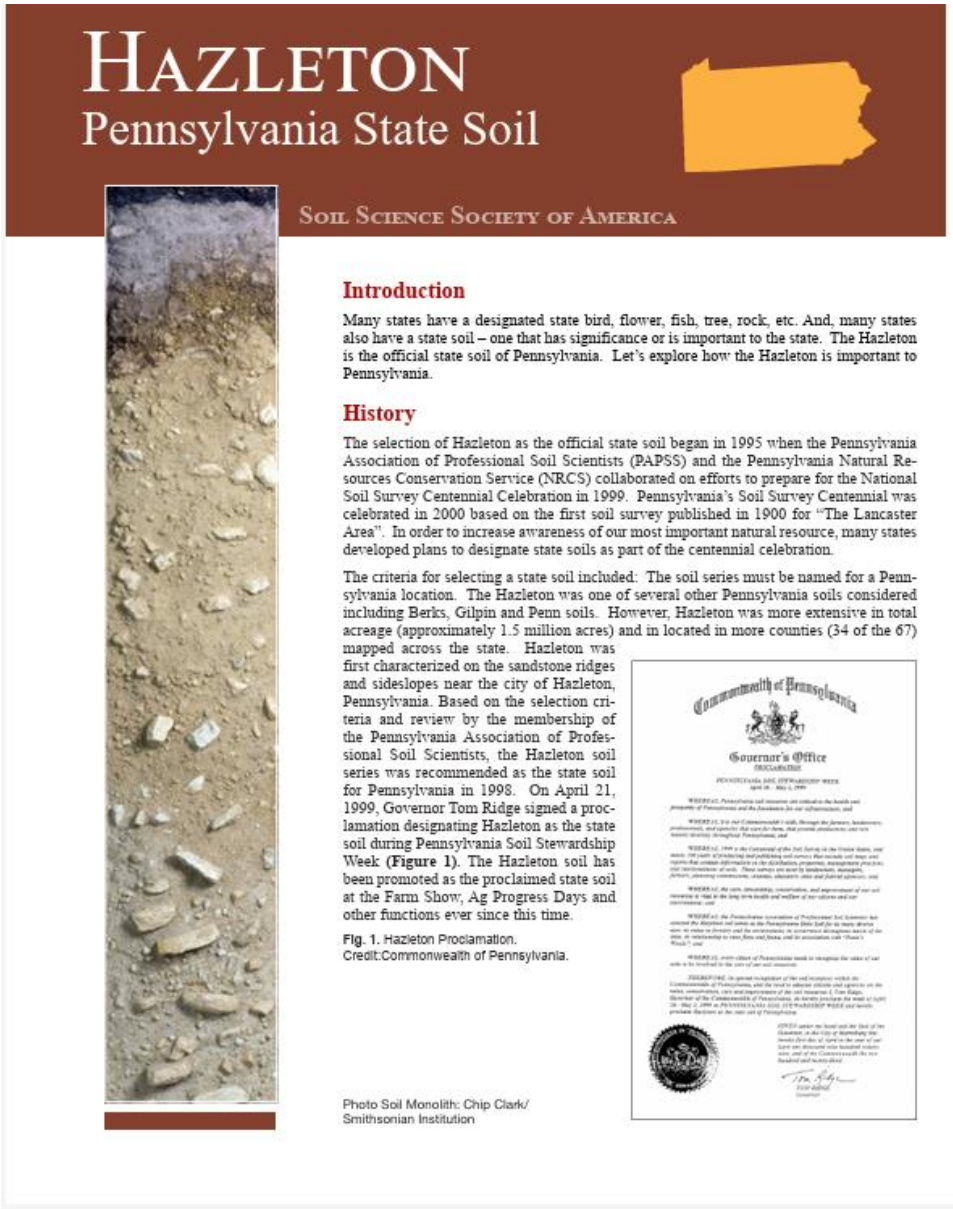
Developed and written by soil scientists to tell the stories of the unique soils found in the US states and territories!

This interactive map features state soils booklets – developed and written by soil scientists to provide in-depth information on each state soil. The booklets include a brief history of how the state soil came to be, where the state soil is found, importance and uses, limitations, management, soil formation, ecoregions and land use, a glossary, and additional resources.

Just hover over any state and select it when highlighted to read more.

Have fun with our state soils word search!

Teachers - use this activity and worksheet in your classroom!



HAZLETON
Pennsylvania State Soil

SOIL SCIENCE SOCIETY OF AMERICA

Introduction

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History

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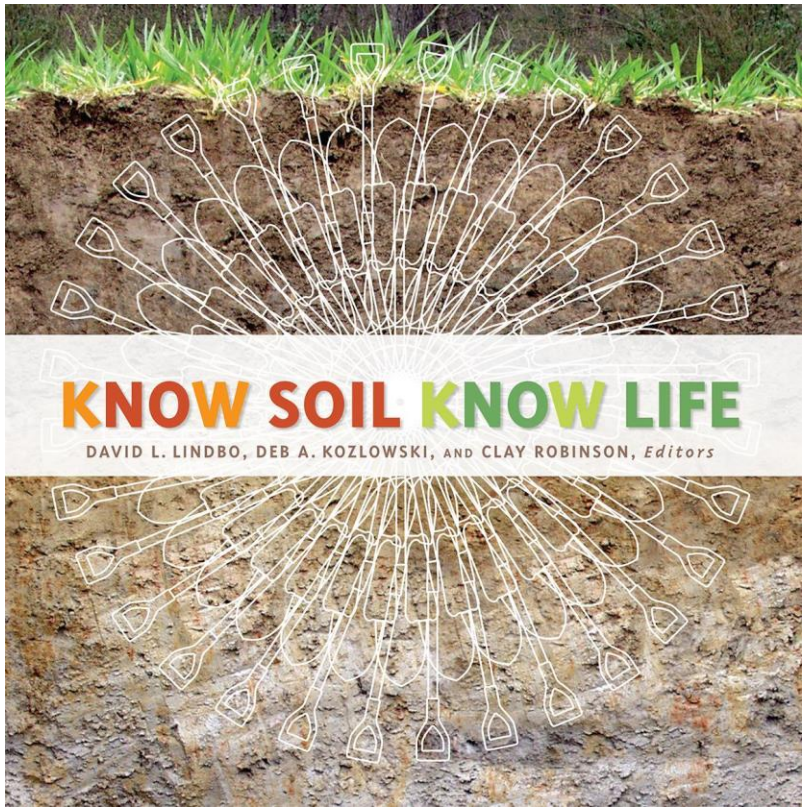
Commonwealth of Pennsylvania
Governor's Office

Fig. 1. Hazleton Proclamation.
Credit:Commonwealth of Pennsylvania.

Photo Soil Monolith: Chip Clark/ Smithsonian Institution

Know Soil Know Life

- Educator's Guide
  - Overview
  - Powerpoints
  - Activities
  - Worksheets



Teachers Inservice and Materials

- Soil Basics/Soil Sampling
- Soil Chemistry
- Soil Biology
- Soils and Climate Change
- Web Resources

- Overview | Powerpoint | Videos | Activities

Grants for Teachers!

Up to 10 teachers could receive up to $500 to pay for supplies to teach about soils to use during the 2025-2026 school year

Visit the Soil Science Society Booth for details!

Deadline: April 22, 2025

https://tinyurl.com/SSSAgrantforteachers

Thank you!

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