Partners: Heather Ryan and Nicole Cannavino
Grade Level: 9th grade
Time Period: Two 40 minute periods (80 minutes)
Topic: Soil Erosion: Slope

# Science and Math Standards

## Next Generation Science Standards

HS-ESS2-5. **Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

## Common Core-Science

CCSS.ELA-Literacy.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic

## NYS Science State Standards

Process Standards

STANDARD 1—Analysis, Inquiry, and Design
Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.
- Mathematical Analysis: Key Idea 2 & 3

STANDARD 6—Interconnectedness: Common Themes
Students will understand the relationships and common themes that connect mathematics, science, and technology
and apply the themes to these and other areas of learning.
- Systems Thinking: Key Idea 1
- Models: Key Idea 2
- Optimization: Key Idea 6

STANDARD 7—Interdisciplinary Problem Solving
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life
problems and make informed decisions.
- Connections: Key Idea 1
- Strategies: Key Idea 2

Standard 4: Students will understand and apply scientific concepts, principles, and theories pertaining to the physical
setting and living environment and recognize the historical development of ideas in science.

2.1p Landforms are the result of the interaction of tectonic forces and the processes of weathering, erosion, and deposition.

2.1s Weathering is the physical and chemical breakdown of rocks at or near Earth's surface. Soils are the result of weathering and biological activity over long periods of time.

2.1t Natural agents of erosion, generally driven by gravity, remove, transport, and deposit weathered rock particles. Each agent of erosion produces distinctive changes in the material that it transports and creates characteristic surface features and landscapes. In certain erosional situations, loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.

# Common Core Mathematics Standards

### Reason quantitatively and use units to solve problems.

CCSS.Math.Content.HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

CCSS.Math.Content.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

### Understand solving equations as a process of reasoning and explain the reasoning.

CCSS.Math.Content.HSA-REI.A.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

### Solve equations and inequalities in one variable.

CCSS.Math.Content.HSA-REI.B.4 Solve quadratic equations in one variable.

### Represent and solve equations and inequalities graphically.

CCSS.Math.Content.HSA-REI.D.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

# Content Objectives

Earth Science:

(ES)C1: Students will be able to make observations about the different soil types and slopes.
(ES)C2: Students will be able to make inferences from their observations about how soil erosion occurs in a natural setting.
(ES)C3: Students will be able to use algebra to determine the annual soil loss of different soil types as a result of a rain event.

Mathematics:

(M)C1: Students will be able to implement Excel in creating a graph for a quadratic equation.
(M)C2: Students will be able to solve a quadratic equation.
(M)C3: Students will be able to interpret mathematically how slope affects the LS factor.
(M)C4: Students will be able to explain graph patterns.
(M)C5: Students will be able to articulate how the quadratic equation for the LS factor of the RUSLE mathematical model is important to our society.

# Academic Language Demands

Earth Science:

*Erosion*: The removal and transport of earth materials by natural agents
*Soil*: loose, weathered rock and organic material. Made up of sand, clay, and silt.
*Topsoil*: A-horizon soil, the top layer of soil
*Subsoil*: Begins with the B-horizon, contains much more clay than topsoil
*Mass movements*: Movement of loose earth material down a slope as a result of gravity
*Creep*: slow, imperceptible downslope movement of soil
*Landslide*: sudden movement of mass of bedrock or loose rock down a hill, mountain, or cliff
*Mudflow*: rapid movement of a water-saturated mass of clay and silt
*Windbreaks*: strips of trees along the windward side of a field
*Contour Farming*: crops are planted in rows parallel to land contours
*No-till*: A method of farming in which plowing, planting, fertilizing, and weed control are all done at the same time

Mathematics:

*Quadratic Equation:*An equation containing a single variable of degree 2. Its general form is $ax^2 + bx + c = 0$, where x is the variable and a, b, and c are constants ($a \neq 0$).
*Coefficients:* A numerical or constant factor in an algebraic term.
*Mathematical Model:* A mathematical model is a description of a system using mathematical language.
*Slope:* The "steepness" of a line.

# Learning Tasks

The soil-slope erosion model will be used in conjunction with Excel to demonstrate how slope affects the overall soil loss. Students will control the model by control the frequency of rain from the clouds, making it an interactive model..

| Activity | Description |
|---|---|
| 1. Erosion, math, and Excel concepts review | ● Beginning of the lesson<br>● (ES) Students will already have information on erosion, will review what they already know<br>● (Math) Students will already know the math that is being used, will review the concepts they will be doing<br>● (Excel) Students will have been previously instructed on how to use Excel, will review how to create a graph in Excel |
| 2. Introduction to Models | ● The instructors will discuss with the students what models are used for<br>● Students will be shown the models that they will be using |
| 3. Models and Observations | ● Students will be able to play with the two models<br>● Students will observe what takes place in the different models<br>● Students will be given their worksheet to record their observations |
| 4. Worksheet | ● Students will already have their worksheet<br>● Students will complete the inferences section and erosion questions |
| 5. Excel | ● Students will graph slope length vs. LS factor<br>● Students will complete the LS factor problems from the worksheet in Excel |
| 6. Wrap-up of Concepts Covered | ● Teachers will answer any remaining questions that the students have<br>● Teachers will ask questions to solidify student learning<br>○ of erosion<br>○ of how math and science relate<br>● Teachers will respond to any misconceptions still remaining |

# Reflection

1. Why is this lesson important?
    a. Soil erosion is an important part of everyday life whether it is for farming, construction, or best land-use practices. Soil erosion can have an effect on agriculture, according to a study by Cornell University soil is being removed 10%-40% faster than it is being replenished but the need for agricultural products keeps rising (Lang, 2006). Increased soil erosion can result in an increase in water turbidity, meaning more suspended solids are present in the water. Mass movement is a result of soil erosion which can be in the form of creep, landslide, or mudflow depending on the soil type, land use, and soil saturation. In order to keep soil erosion in check, the RUSLE mathematical model is used. Having a solid understanding of the mathematics behind soil erosion is helpful both for our economy and the environment.
2. How will you assess student learning? Formative? Summative?
    a. During our lesson student learning will be assessed formatively. Specifically, we will be using an earth science and a math worksheets coupled with an Excel spreadsheet. The worksheets will include problems that intertwine earth science and mathematics. There will be numerous questions that assess students on their understanding of soil erosion and the factors that determine annual soil loss. Additionally, students will be evaluated on their ability to complete Algebraic problems based upon the graph they make in Excel. This activity is a great practice exercise in mastering the tool Excel.
3. How will you use the concept of abstraction for teaching science and math?
    a. Certain concepts in science and math are too abstract for the students to be able to even begin to understand what they mean. Through modelling you can show students these abstract concepts and make it “real” for them. For our lesson we are having students observe that rain can erode soil and how different variables can affect the soil erosion. Students can generally understand that water can erode soil but once you go in deeper into soil strength and slope the students can often get lost.

4. How will your lesson help students to improve math and computational thinking skills?

    a. In this lesson, students will use Excel to solve mathematical problems. They will prove graphically that the steeper the slope, the higher the LS factor. By observing the soil erosion models students will be able to relate what they saw to what they will calculate in their homework . For instance, if a student calculates a high annual soil loss for a shallower slope than a steeper slope, the student will know that they need to redo their math since the models demonstrated something different.

**Sources**


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