Plant Roots, Soil, and Groundwater

Infiltration in the Arroyo Unit, Lesson 4

Lesson Summary: Students explore how plant roots can slow erosion and increase infiltration.

Suggested Timing: 1 hour (grass should be started at least a week to 10 days before this experiment)

New Mexico State Standards

Performance Expectation(s):

MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
Developing and Using Models: Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to describe phenomena. Engaging in Argument from Evidence: Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	LS2.B: Cycle of Matter and Energy Transfer in Ecosystems: Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. LS2.C: Ecosystem Dynamics, Functioning, and Resilience: Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	Energy and Matter: The transfer of energy can be tracked as energy flows through a natural system. Stability and Change: Small changes in one part of a system might cause large changes in another part.

Evidence Statements:

- MS-LS2-3 Evidence Statements
- MS-LS2-4 Evidence Statements
- MS-LS2-5 Evidence Statements

ELA CCSS Connections:

- SL.8.5. Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS2-3)

Math CCSS Connections:

- 6.EE.C.9. Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS2-3)

Content Objectives and Daily Learning Targets	**Objectives**: ● I can explain how plant roots help prevent erosion and increase infiltration.
Focus Question	How do plant roots impact erosion and infiltration?
Language Objectives	● Students can describe what they observe in writing and orally. ● Students can correctly use scientific vocabulary in their writing.
Vocabulary	● **Erosion** - process in which earth materials are worn away and transported by natural forces such as wind or water. ● **Infiltration** - the downward entry of water into the soil. ● **Stormwater -** surface water in quantities large enough to run off resulting from heavy precipitation.
Materials	● Soil with and without grass ● Spray bottle with water or watering can with shower head ● Lab sheets or science journals
Preparation before class	● Use the models with and without sprouted grass seeds, as built in Erosion Lesson 1.4 and 1.5. If you did not build and sprout seed on these models, you can get sprouted wheat grass or plants with developed root systems. These can be compared to loose potting soil in trays.
Assessments (Formative/ Summative), Rubrics, Success criteria	● Lab report ● Participation in discussion ● Success Criteria ○ Students are able to describe the role that plant roots play in controlling erosion and increasing infiltration. ○ Students make connections between roots, stormwater runoff, and the water table.
EL Supports	● Think-pair-share helps students practice what they will say before sharing with the whole class.
Culturally Relevant Strategies	● Students learn about the local environment. ● Students practice social and academic skills.
Special Education Modifications	● Follow student IEP.

Santa Fe WATERSHED ASSOCIATION

	● Think-pair-share helps students practice what they will say before sharing with the whole class.

Lesson Plan Details

ENGAGE (~10 min):	● Give students time to look at the seeded and unseeded models of the arroyo. ● What do you see? Are there visible differences between the seeded and unseeded models? ● Do a think-pair activity: ask them to predict what they think will happen when water is poured on each and record this in their journals or on the lab handout as their hypothesis.**Hypothesis: How do you think that the plants will impact the rate of erosion and infiltration?**
EXPLORE (~15 min):	● Have students read the procedure in the Roots, Soil, and Infiltration Lab handout. ● Ask students to explore what happens when they add water to the two models. ● Have them record their observations in their journals or on the lab handout.
EXPLAIN (~10 min):	● Review key vocabulary, especially stormwater. Ensure students understand the difference between stormwater and rain. Stormwater is water that is not absorbed into soil and rapidly flows downstream, increasing the level of waterways. Rain becomes stormwater when there is more water than the soil can absorb. ● Ask students to share what they noticed. ● Ask them to pair-share to connect this model to the real world. Record their thoughts in their lab handouts or journal.
ELABORATE (~15 min):	● Have students look at the diagrams of root systems of different plants. ● Do a think-pair to discuss what plants they would recommend to slow runoff and increase infiltration. ● Discuss the history of Santa Fe's ecology, including grazing, habitation, and fire suppression. ○ Historically, Santa Fe was a grassland. Grazing and fire suppression converted it into a piñon-juniper shrubland by the 1800s. This process eventually removed the majority of grasses that historically held loose soils in place. Without dense roots to slow it down, water began to erode the low points in the landscape, creating arroyos. As people built on the land, this increased the problem through stormwater. Impermeable surfaces allowed the water to collect, flow, and cause damage. The rain off of roofs, parking lots, and other hard surfaces was seen as a potential flooding problem by city planners. They wanted to remove the water from the city, so directed it into the arroyo system. This process of concentrating water has made the scouring of arroyos even worse.

EVALUATE (~10 min + Homework):	• Ask students to think about groundwater levels (the water table) and the ability of a plant's roots to access water. • If infiltration is happening at the bottom of the arroyo instead of the surface of the surrounding ground, how will this impact the kinds of plants found on the banks? (Think of the different soil types.) What happens if the arroyo gets deeper? How could this be improved? • Homework: Have students draw a diagram of where they think groundwater would be in an area without an arroyo and with an arroyo (Groundwater and Plant Roots, Student Handout). Ask them to include plant roots in their diagrams.

Additional Sources:

- 5 Es of Science Instruction
- 5E Model of Instruction
- ISEC model of lesson sequence