HU GK-12 Activity

TITLE: Erosion and Plant Root Holding Power

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DCPS STANDARDS: E.6.1, E.6.2

GOALS:

1. Students will understand the role that plants play in watershed health.
2. Students will understand how the roots of plants keep soil on land.

OBJECTIVES:

1. After a demonstration on how plant roots hold dirt in place during rains, scholars will write a paragraph explaining how this acts to control erosion.

PREREQUISITE KNOWLEDGE:

Background

Erosion is displacement of solids (soil, mud, rock and other particles) usually by the agents of currents such as, wind, water, or ice by downward or down-slope movement in response to gravity or by living organisms (in the case of bioerosion). Erosion is distinguished from weathering, which is the breaking down of rock and particles through processes where no movement is involved, although the two processes may be concurrent. Erosion is an intrinsic natural process but in many places it is decreased by human land use. Poor land use practices include deforestation, overgrazing, unmanaged construction activity and road or trail building. However, improved land use practices can limit erosion, using techniques like terrace building and tree planting. A certain amount of erosion is natural and, in fact, healthy for the ecosystem. For example, gravels continuously move downstream in watercourses. Excessive erosion, however, does cause problems, such as receiving water sedimentation, ecosystem damage and outright loss of soil.

The rate of erosion depends on many factors, including the amount and intensity of precipitation, the texture of the soil, the gradient of the slope, ground cover from vegetation, rocks, land use, and possibility of erosion from speed of a stream. The first factor, rain, is the agent for erosion, but the degree of erosion is governed by other factors. The first three factors can remain fairly constant over time. In general, given the same kind of vegetative cover, you expect areas with high-intensity precipitation, sandy or silty soils and steep slopes to be the most erosive. Soils with a greater proportion of clay that receive less intense precipitation and are on gentle slopes tend to erode less. But here, the impact of atmospheric sodium on erodibility of clay should be considered. The factor that is most subject to change is the amount and type of ground cover. In an undisturbed forest, a litter layer and an organic layer protect the mineral soil. These two layers protect the soil by absorbing the impact of raindrops. These layers and the

underlaying soil in a forest are porous and highly permeable to rainfall. Typically only the most severe rainfall events will lead to overland flow in a forest. If the trees are removed by fire or logging, infiltration rates remain high and erosion low to the degree the forest floor remains intact. Severe fires can lead to significantly increased erosion if followed by heavy rainfall. In the case of construction or road building when the litter layer is removed or compacted the susceptibility of the soil to erosion is greatly increased.

Roads are especially likely to cause increased rates of erosion because, in addition to removing ground cover, they can significantly change drainage patterns. A road that has a lot of rock and one that is "hydrologically invisible" (that gets the water off the road as quickly as possible, mimicking natural drainage patterns) has the best chance of not causing increased erosion.

Many human activities remove vegetation from an area, making the soil easily eroded. Logging can cause increased erosion rates due to soil compaction, exposure of mineral soil, for example roads and landings. However it is the removal of or compromise to the forest floor not the removal of the canopy that can lead to erosion. This is because raindrops striking tree leaves coalesce with other raindrops creating larger drops. When these larger drops fall (called through fall) they again may reach terminal velocity and strike the ground with more energy then had they fallen in the open. Terminal velocity of raindrops is reached in about 8 meters. Because forest canopies are usually higher then this, leaf drop can regain terminal velocity. However, the intact forest floor, with its layers of leaf litter and organic matter, absorbs the impact of the rainfall.

Heavy grazing can reduce vegetation enough to increase erosion. Changes in the kind of vegetation in an area can also affect erosion rates. Different kinds of vegetation lead to different infiltration rates of rain into the soil. Forested areas have higher infiltration rates, so precipitation will result in less surface runoff, which erodes. Instead much of the water will go in subsurface flows, which are generally less erosive. Leaf litter and low shrubs are an important part of the high infiltration rates of forested systems, the removal of which can increase erosion rates. Leaf litter also shelters the soil from the impact of falling raindrops, which is a significant agent of erosion. Vegetation can also change the speed of surface runoff flows, so grasses and shrubs can also be instrumental in this aspect.

ESSENTIAL QUESTIONS:

1. Do the roots of plants make a difference when it rains and water is pushing the dirt down a slope toward the river?
2. How do plant roots hold dirt in place?

LABORATORY MATERIALS:

Two collection bins, two coffee cans (11.5 oz), one board, two ½ gallon cardboard milk cartons with panel removed, rain cup (yogurt container with small holes punched in the

bottom), water, two measuring cups (250 mL), 4-inch house plant in pot, empty 4-inch pot, soil.

DIFFERENTIATING INSTRUCTION:

Thomas will explain the activity to English language limited students.

RATIONALE:

This activity is designed to demonstrate how the roots of plants control erosion by holding dirt in place during rains.

RESEARCH ACTIVITY:

1. Set the milk cartons as ramps draining into the collection bins.
2. Remove the plant from its pot and set it into the high end of one of the milk carton ramps. This is the test situation: a plant without a pot, on a slope, soon to be rained upon. To make a comparison, a control situation must be assembled and tested.
    a. At this point scholars will list the variables that must remain constant (independent vs. dependent variable).
3. Measure an equal amount of soil into a pot and invert the dirt into the high end of the other milk carton ramp.
4. Rain equal amounts of water on the plant and on the dirt pile. Make sure the rain cups are at the same height, not just "over" the plant or the dirt. The leaves of plants help scatter the rainfall, which reduces the pressure the water exerts on the earth. It is an effective visual to rain first on the plant and then on the dirt pile.
5. Compare the water clarity in the two collection bins.

EVALUATION AND ASSESMENT:

Scholars will write a paragraph describing how plants in the environment reduce erosion.