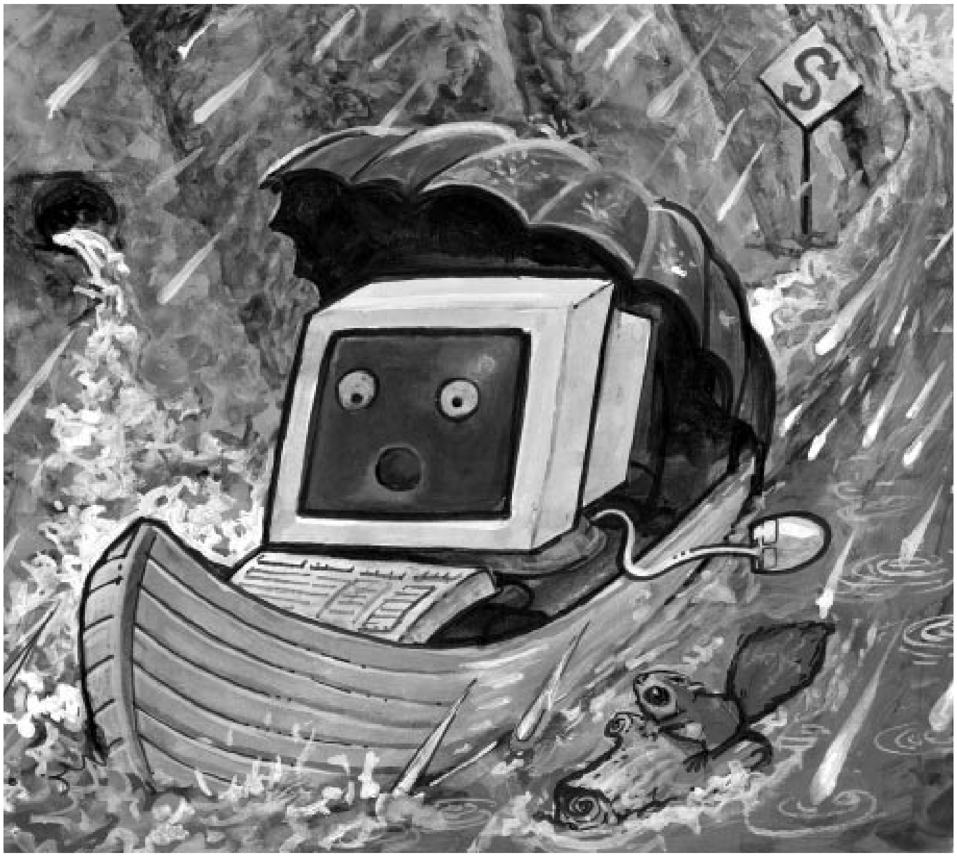
Should Ditches Be Graded?

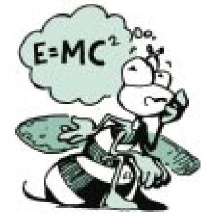


Testing Unpaved Roads With a Computer Program

Meet Dr. Laurie Tysdal:

I like being a scientist because I learned the building blocks of how things work in the natural world around us. And now I can figure out new things on my own, using those building blocks. I became interested in natural resources when I traveled new places and saw plants and rocks and rivers that were different than the ones at home. I wanted to know why.

Dr. Laurie Tysdal



Thinking About Science

For many types of science, an important goal is to be able to predict events that might happen in the future. For example, you know that people try to predict the weather every day! Like the weather, most things in the natural world are so complicated that scientists are not always successful predicting what might happen. With the use of computers, scientists are able to consider the *relationship* of many more *variables* at the same time. With computers, they can study more complicated systems. This is because computers can keep track of millions of bits of information at once. In this study, the scientists compared their actual observations and measurements of *soil erosion* with the *estimates* made by a computer program. They wanted to know how well the computer program could estimate actual soil erosion. If it could estimate soil erosion fairly well, the computer program could become a useful tool for prediction for other places. This is a good example of how science can help society and the environment.

Thinking About the Environment

Whenever humans build something, they

sometimes disturb the natural environment. In forested areas, people often build unpaved roads for occasional use (Figure 1). Even though these roads are useful to humans, they can cause soil erosion and *sedimentation* in the natural environment. This is primarily because rain runs freely across the roads into ditches, carrying soil particles with it. If sediment from roads reaches streams, it can harm the fish or other animals and plants that live in the stream. Scientists want to know how to build roads that do not cause sediment to reach forest streams. Because people want to use these kinds of roads, scientists are looking for ways to design roads that minimize soil erosion and sedimentation. Whenever humans build something, it is always wise to look for ways to reduce harm to the environment.

Introduction

Although it may not seem like it, the way water runs across and down an unpaved, *insloping* road is complex (Figures 2 and 3). Things affecting it include the length of the road, the steepness of the road, the type of soil, the *cutslope*, the steepness of the inslope, the ditch, and the *culvert* (Figures 2 and 3). All of these variables also affect how much soil erosion and sedimentation occurs. Soil erosion and sedimentation reduce the diversity of the natural environment. When soil is eroded and sedimentation occurs, important nutrients are carried away from the soil. The nutrients and sediments eventually run into streams and rivers. When sediment flows into streams and rivers, it can

Figure 1. An unpaved mountain road.

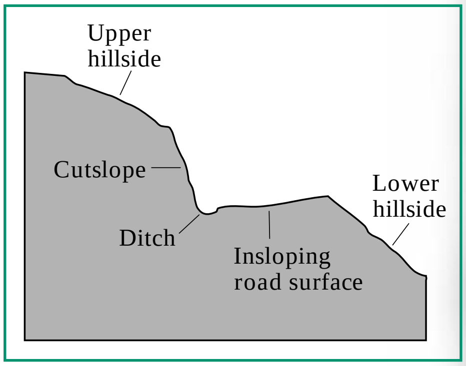


Figure 2. Cutaway view of insloping road.

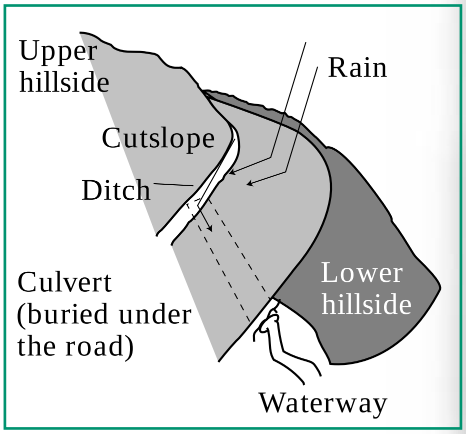


Figure 3. Illustration of insloping road.

Glossary

relationship (re **la** shen ship): When two or more things are connected in some fashion.

variables (**ver** e uh buls): Things that can vary in number or amount.

soil erosion (**soy** ul e **ro** zhun): Movement of soil from one place to another, usually by wind or water.

estimates (**es** tuh mets): Calculated values that come close to the actual value.

sedimentation (se **duh** men **ta** shen): The process of depositing soil and other particles carried by wind or water.

insloping (**in** slop ing): Hillside road surface that slopes down and in the direction of the uphill slope.

complex (kälm **pleks**): Complicated and having many different relationships.

cutslope (**kut** slop): Uphill soil bank along a hillside road.

culvert (**kul** vürt): A pipe placed under a road.

watershed (**wä** tür shed): Land area with small streams that delivers water and sediment to a larger stream.

data (**da** tuh): Factual or measurement information.

associated (uh **so** she a ted): Closely connected in function.

Pronunciation Guide

a	as in ape	ô	as in for
ä	as in car	u	as in use
e	as in me	ü	as in fur
i	as in ice	oo	as in tool
o	as in go	*ng*	as in sing

affect the animals and plants that live there. For example, sediment can smother the eggs of fish, causing the eggs to die. The scientists in this study wanted to find a way to predict how much erosion would be caused by unpaved roads.

Reflection Section

- Have you seen sheets of water flowing across a paved road during a heavy rain? Do you think the road is causing soil erosion? Why or why not?

- What basic force causes water to run downhill? Do you think there is a way to stop water from running downhill? Why is this important for people who build roads?

Methods

The scientists decided to test a computer program that had been developed for agricultural lands. The computer program was designed to look at an area of cropland as a *watershed*, and to predict how much soil erosion might occur. The scientists decided that an unpaved, insloping road could be considered a watershed also. They selected 74 sections of unpaved road along the mountainous coast of Oregon. From those sections they collected *data* on cutslope height and plant cover, road length and steepness (or grade), and the characteristics of the ditch (look again at Figures 2 and 3). They also collected data on soil erosion. They did this by measuring how much soil had been washed through the culverts and into a collection bucket (Figure 4).

The scientists decided that the computer program could reasonably estimate actual soil erosion. They decided this because the actual amount of soil erosion was close to what the computer program had calculated it would be. Therefore, they were able to use the computer program to determine which road characteristics (see Figures 2 and 3) were *associated* with greater soil erosion. To do this, they developed a number of different combinations of road characteristics and placed numbers describing those characteristics into the computer. For example, they developed combinations that represented roads of different lengths, or combinations that represented roads of different steepness (or grade). They changed only one of the characteristics at a time. That way, they were able to use the computer program to identify which characteristics most affected soil erosion and sedimentation (Figure 5).

Figure 4. Culvert pipe and collection bucket used to measure soil erosion.

Reflection Section

- Why did the scientists use data from real unpaved roads

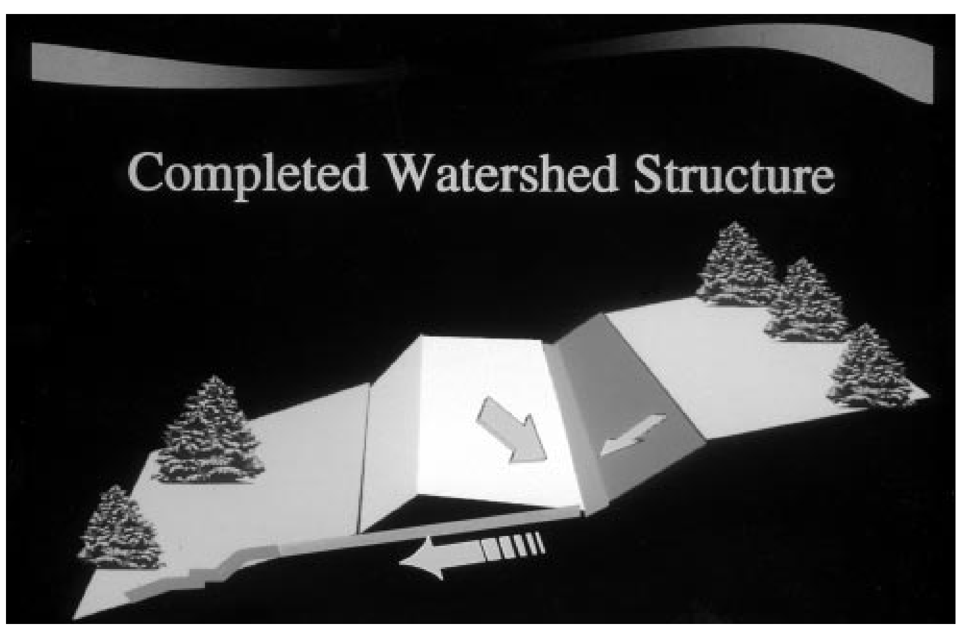


Figure 5. Computer image of an insloping road.

Hit the Road!

To provide a way for people to reach the downhill ski area for the Salt Lake Games, a mountain road had to be built. As you are learning from reading about insloping mountain roads, a mountain road is a complex thing to build. As they planned the road, the 2002 Games planners discovered that not everyone agreed on the best way or path to build the road. Some people were concerned about the damage that might be done to the natural environment. Instead of arguing, the planners found a better way to build the road. Can you think of what they did? They invited everyone to plan the road together. That way, everyone's opinion was heard. The finished road met everyone's needs. It provided access to the downhill ski area, and it protected natural areas and the wildlife that live there. You can see that working together really works!

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to check the computer program?

- How did the scientists know when a road characteristic affected soil erosion?

Results

From the computer program, the scientists found that longer unpaved roads, and roads with steeper grades cause greater soil erosion. In all cases, the ditch also experienced some soil erosion. Graded ditches (those that are maintained using large machines that smooth and clean them) caused more erosion than ditches that were left alone. Higher cutslopes or those with fewer plants eroded more than lower cutslopes or ones with more plants growing on them. However, cutslopes were not responsible for very much erosion. This is because the soil on cutslopes is better able to absorb water. Most of the water that causes erosion flows across the road and into the ditch. After water flows into the ditch, it flows through a culvert and down the hillside. When it flows down the hillside, it may follow a waterway that is natural or one that humans have created. The scientists found that long waterways cause less sedimentation into streams and rivers below. This is because sediment is left along the waterway as the water flows downhill. If a waterway is short and the water enters a stream quickly, it carries more sediment from the road into the stream.

Reflection Section

- If the unpaved road had not been built, what would have happened to the rain water as it fell into the forest?

- When water runs across an unpaved road in the forest, where does it eventually end up?

Implications

By using a computer program, the scientists were able to better understand how different road characteristics affect the amount of soil erosion and sedimentation. Imagine how difficult it would be to find real unpaved road sections with such a large variety of different characteristics! Even if the scientists could find that many road sections, they would have to observe and measure the amount of erosion on each one. And they could only do that when it was raining! And, their measurements would be different depending on how hard it was raining and for how long the rain fell. You can see how useful a computer program can be. When scientists want to study something very complex, such as soil erosion from unpaved roads, it is helpful to have a computer program. But remember, the scientist must first test the computer program with actual data, to make sure it is accurate.

Reflection Section

- Computer programs can help scientists understand other complex situations. Name three other examples of complex situations in which computer programs might be used.

- Imagine that you are the scientist. What would you tell people who ask you for the best way to design unpaved forest roads? Remember, you can vary some of the characteristics (see Figure 1), but not all of them.

FACTivity

In this FACTivity, you will build your own insloping road! Get two large cardboard boxes about 30 inches square and at least 12 inches high. Your teacher should remove the lid flaps from the boxes. Line the boxes' bottom and sides with plastic. Fill each box about half full with soil.

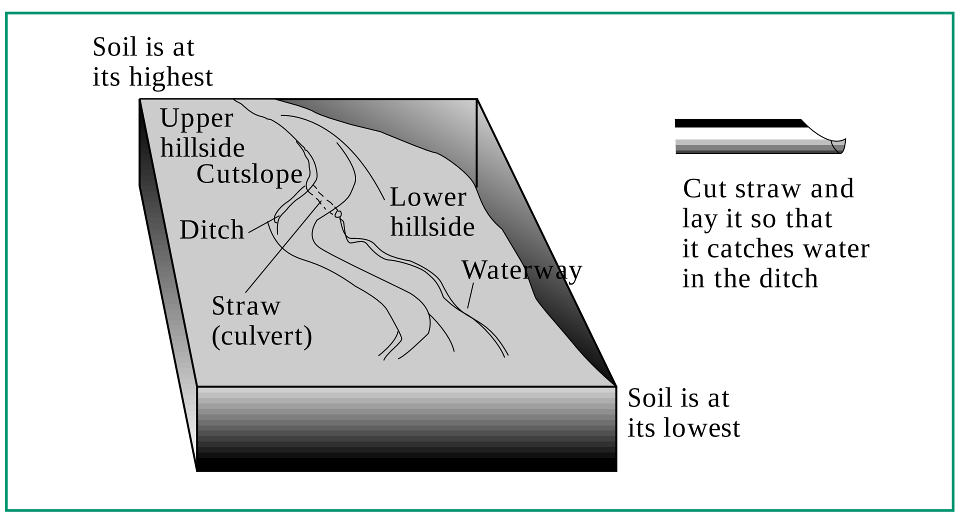
Start by building a "hillside" in each box. The hillside should slope in two directions (see illustration). Now, begin building an insloping mountain road. Remember to slope your road surface inward. Look at Figure 1 in the article for an example. Don't forget to build a ditch on the inside. Use plastic straws for culverts along your road. You will need to cut the edge of the straw before burying it under the road (see illustration). Then, build a waterway from the "culverts" down the hillside by creating ditches down the hillside. The waterways should go down to the lowest corner of the box. In one of the boxes, put plugs of grass (small sections of grass dug up with about 1 inch of soil) on the upper hillside, the cutslope, and the downslope (but not on the road or waterway).

When you have finished building a road in each box, use a watering can to pretend that it is raining. What happens to the water and the soil in each box? Is there a difference in the amount of erosion (soil being carried down the hillside) between the two boxes? Why or why not? What conclusions can you make about the construction of insloping mountain roads? What could you do to reduce erosion for your own insloping road?

From Tysdal, Laurie M.; Elliot, William J.; Luce, Charles H.; and Black, Thomas A. (1999). Modeling erosion from insloping low-volume roads with WEPP watershed model. National Academy Press: *Transportation Research Record*, 2(1652): 250-256.

Website:

http://forest.moscowfsl.wsu.edu



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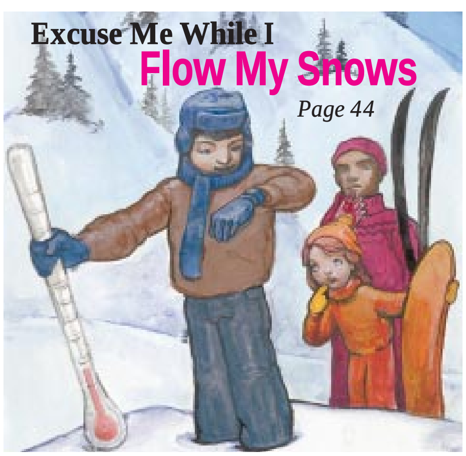

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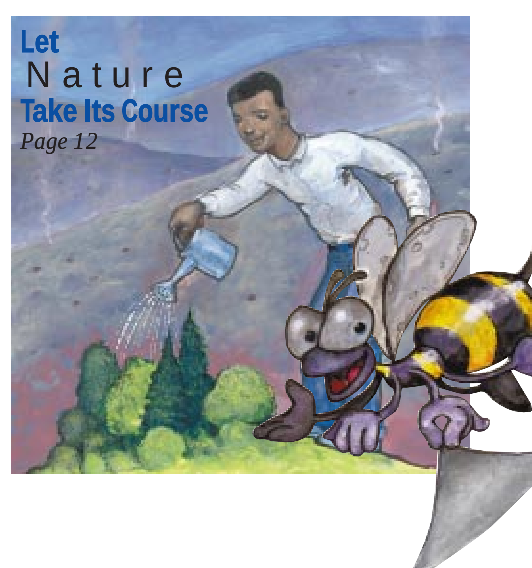

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