Geomorphology
RED BEANS AND RICE: THE CAJUN LAB!!
Mass movements and evolution of hillslopes

Background

It can be pretty tough to watch a hillslope evolve. We just don't have the time in our short lives. So geomorphologists frequently turn to experiments to get insight into how real-world systems work. That's what today's lab is all about. We will simulate how a hillslope evolves through time by looking at slope failures in red beans and rice (not mixed and definitely not cooked!). The apparatus you will use is a narrow (2.54 cm wide) clear acrylic box (57.1 x 36.8 cm) with a solid floor and backwall, but with a sliding wall on the other side. The box will be filled by either red beans or rice. You will lower the sliding door in small increments; this simulates erosion and downcutting of a river at the base of the slope (it simulates a change in base level, if you recall that terminology)(see Figure 1).

This lab will be done in groups, with specific roles assigned to different people in the group.

Goals

At the end of this lab you should:

- Be able to explain how experiments can be used to understand the long-term behavior of some geomorphological systems
- Be able to explain the role of slope failures in the evolution of slopes and landscapes, for the particular case we're investigating
- Have a better understanding of how the material that makes up a slope may control the nature of a mass movement event.

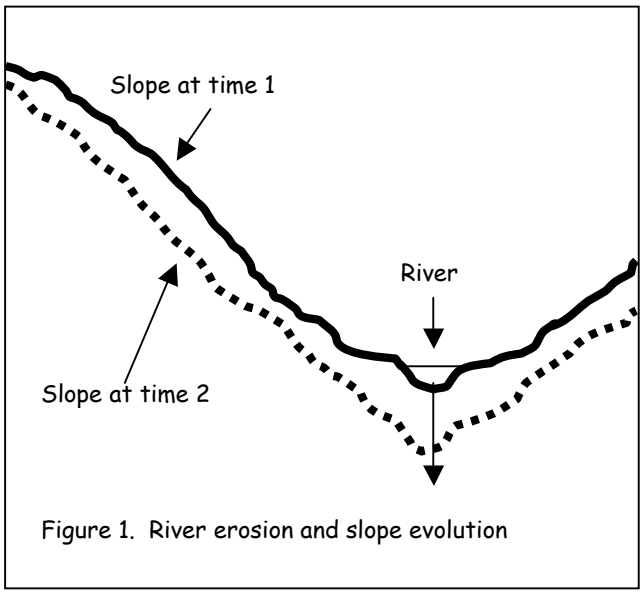

Figure 1. River erosion and slope evolution

Materials you'll need

- One slope failure simulation box
- Enough red beans or rice to fill the box to within 5 cm of the top.
- A centimeter ruler
- Two different color markers
- A bucket (to catch falling beans or rice)
- A pad of Post-it™ notes
- Electronic scale

Who should do what in each group

This lab WILL go better if each person has a role to fill. Here are the roles:

- *Landslide maker*. This person will move the sliding door down incrementally. It takes a careful touch and is not easy to do well. This person will also carefully draw slope profiles on the sidewall of the box.
- *Bean or rice catcher*. It's your job to catch the beans or rice that fall and give them to the weight taker.
- *Weight taker*. This person will weigh the beans that are caught after each incremental movement of the gate
- *Data recorder*. This person will record the weights taken by the Weight taker. They should do it on a separate sheet, then enter the data into Excel later. *Very important*: A weight must be recorded for **every** movement of the gate; a value of 'zero' should be recorded for a movement that doesn't lead to a weigh-able amount of beans or rice. The data recorder can also take notes on any observations made during the experiment(s). One strategy for the Data Recorder: open a Word document and record answers to questions and general observations in Word, while recording measurements on a separate sheet.

1. First, take a minute to think about what you'll be doing and try to predict what the outcome will be: You will lower the sliding door in 0.5 cm increments. When the slope fails you'll catch the stuff that fails in the bucket. You'll then weigh the beans that failed at every increment (recording zero values when no beans or rice fail). Eventually, you'll make a plot of increment number (1,2,3, and so on) versus weight of material caught. **On a separate sheet of paper sketch what you think this plot will look like, with increment number on the horizontal axis. Also, take five minutes to write down *how* you think the slope will fail. What will the slope profile look like after it fails? Just go with your intuition here, there are no 'right' answers. You should include your hypothetical sketch and ideas in your final lab write-up.**

Getting' the feel for slope failure (see figure 2 for recommended set-up)

1. Make sure that the sliding end door is raised up to close off the box.
2. Fill the slope failure apparatus with either the beans or the rice.
3. Practice, practice, practice. Try moving the sliding door down in 0.5 cm increments and catching all of the beans or rice that come out of the gate. Try to be precise in each movement. Also, don't bump the apparatus if you can help it. Handle it gingerly. One bump can lead to a big failure and you'll have to start over.
4. The Weight taker should get comfortable with efficiently weighing the failed material and setting it aside, so that the bucket's ready for the next increment.
5. The recorder should think very carefully about how best to record the data (see below)

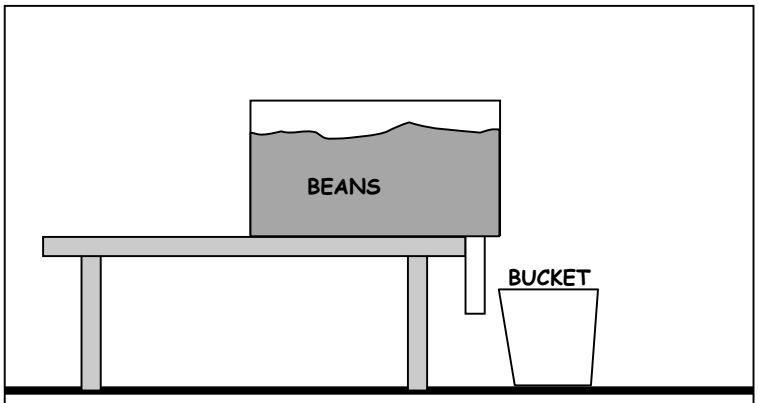

Figure 2. One way to set things up.

Doin' the experiment

Now that you know how to work the apparatus, weigh the stuff, and record it, let's do the actual experiments.

2. Make note of what the material looks like through the sidewall. Does the material look isotropic (i.e. randomly-oriented grains everywhere) or anisotropic? Do you see a preferred orientation to the grains? Write down what you observe here.
3. Take a few grains of beans or rice and measure their long, short, and intermediate axes. The recorder should make note of the average grain shape.

- Re-fill the apparatus.
- The Landslide maker should move the sliding door in 0.5 cm increments, waiting between each for the Weight-taker to do his/her thang.
- While the Landslide maker waits, he/she should use the Dry-Erase marker to carefully and gently draw the slope profile on the clear wall of the apparatus. Post-it™ notes can be used to mark which profiles correspond to which increment of downward movement.
- After drawing in the slope profile, measure the slope length as a best-fit line with your ruler.
- When a failure occurs the Weight taker should weigh the material that fails.
- The recorder should record the weight and record observations about what the failures are like. An Excel spreadsheet should have the following columns:

Gate-drop increment	Weight of failed material (g)	Length of slope	Comments/notes

- **BEWARE: you should probably record your data by hand then enter it into Excel. Some folks have lost data due to system crashes. Bad news…**
- Do this until the top of the sliding door is about 5 cm above the base of the apparatus.
- Raise the door.
- Using a piece of tracing paper, trace your experimental slope profiles from the sidewall onto the paper. Label the tracing paper appropriately ("Red beans, run 1, 0.5 cm increments" for example).

Replication is imperative in experiments. Can you replicate (approximately) what you did before? The only way to find out is to do it again. Also, you want to capture a whole bunch of slope failures, so…

- Plan on repeating the experiment several times to see if you get replicable results and to get a moderately large number of slope failure samples (60 or so would be nice).

Data analysis

- Use Excel to create plots for each of your test runs that show depth of erosion on the horizontal axis (amount of downward movement of the sliding door) versus the amount of material generated by each slope failure.
- Make a similar plot with the same horizontal axis, but with a different value on the vertical axis. This value should be the ratio between the weight of failed material to the slope length at each increment of 'erosion.' This is essentially the weight of material produced by slope failure per unit length of slope.
- Then take all of the weight data from all of your experiments and combine it into a single column. Sort this column from the lowest to the highest value. Plot these data as a cumulative frequency histogram (I will show you how to do this using Excel's functions).
- If you did an experiment with Red Beans, give your data to the groups that did an experiment with rice. If you did an experiment with rice, give your data to the groups that did an experiment with Red Beans.
- Look over the slope profiles, the plots of all of the data (red beans AND rice) and see if you can determine any kind of pattern, differences in pattern, or if they tell you anything about how slopes evolve.

Lab write-up

As it turns out, the very experiment that you just did is fairly cutting-edge research, believe it or not. I got the idea for the experiment from the January 17, 1997 issue of *Science* (Densmore *et al., 1997)*, the premier U.S. journal of science. It's tough to get published there, but this experiment did…. I have copies of the article and you should pick one up so that you can complete the lab write-up.

Your write-up should have the same basic structure as the one we did for the tectonic geomorphology lab:

Introduction

This section should include your response to question 1 and a summary of why this research is important. You can get additional insight into the importance of the experiment by reading through Densmore *et al*. (1997). What hypothesis are you testing or idea are you exploring?

Methods

This section should be a thorough discussion of the methods employed.

Results

This section should include your answers to questions 2 and 3, as well as a discussion of the results for both the red beans and the rice experiments (all groups must look at data from both types of materials). Remember: no interpretations!

Discussion

In this section you should address the following questions: How do you interpret your results? What do they mean? What do they imply for the evolution of landscapes and the role of landslides in that evolution? Were your initial predictions borne out, or did something else happen?

Where might there be sources of error? How is this experiment like the real world, and how is it different?

You should conclude this section with a comparison of your results with those of Densmore *et al*. (1997). In many ways, we are trying to replicate this experiment. Was it replicable?

Conclusions

Summarize your main conclusions and, finally, based on the reasoning in the Science article and your own intuition, do you think that the RED BEANS AND RICE EXPERIMENT (!!!) is a good model for slope evolution? Explain your answer in a short paragraph.

All-told, I expect about 4-5 pages of a well-organized, well-written lab write-up.

HAVE FUN!!!! Otherwise, "it don't add up to a hill of beans."

Humphrey Bogart, Casablanca