Surface Process Hazards—Unit 3, Part 2, Material Strength: Driving or resisting forces, who's the winner?

Sarah Hall (College of the Atlantic) and Becca Walker (Mt. San Antonio College)

In this exercise, you will consider how the properties of different Earth materials contribute to mass-wasting potential.

Part 1: Strength

You have already investigated the concept of stress, the force acting over a specific area. **The Normal Stress is only a part of the resisting forces.** In considering whether or not a particular slope will fail, we also have to consider the **strength** of the block.

1) What is the relationship between strength and resisting forces? (circle one)
   (a) The stronger the material, the higher the resisting forces.
   (b) The stronger the material, the lower the resisting forces.

Different Earth materials have different strengths depending on the material's:

- **cohesion:** the ability of a particular material to stick together
- **internal friction:** In unconsolidated sediment, sediment grains are in contact with one another. Internal friction refers to the degree of friction between individual grains. If water is present, the grains get pushed farther apart, lowering the internal friction.

Cohesion and internal friction can be measured in the lab. Below are some abbreviated formulas to show you how cohesion and internal friction relate to material strength. We won't use these formulas to make calculations, but they will be helpful in thinking about how different Earth materials have different mass-wasting potentials.

Strength = Cohesion + Internal Friction

Internal Friction = coefficient of friction x (normal stress – pore pressure)

2) Briefly describe the difference between sand and clay with respect to particle size and porosity.

3) Do a thought experiment where you are walking over a surface made of clay (i.e., clay-sized sediment.) Are you more likely to slip walking over dry clay OR wet clay?

4) Do another thought experiment where you are jogging over a surface made of sand. Would it be easier to jog on dry sand, moist sand, OR very wet sand? Briefly explain your choice.

5) Do one final thought experiment where you are building a sandcastle. Would it be easier to build the sandcastle using dry sand, moist sand, OR very wet sand? Briefly explain your choice.

6) Based on your responses to questions 3–6 and the strength equation, describe:
(a) How water influences the cohesion of unconsolidated sediment;

(b) How water influences the internal friction of unconsolidated sediment.

(c) How water influences the strength of unconsolidated sediment.

7) You already know that for a mass wasting event to occur, the driving force must be greater than the resisting forces. Spend a bit of time brainstorming about factors would increase the driving force AND factors would increase the resisting force. Record as many ideas as you can think of and record them in the space below.

Increasing Driving Force **Increasing Resisting Force**

Part 2: Applying what you know to some real study areas

In Unit 2, you identified landscape features present in a variety of U.S. study areas. Refer back to these study areas and carefully examine the following maps:

- ✓ SRTM-based hillshade image
- ✓ aerial imagery
- ✓ topographic map
- ✓ geologic map
- ✓ population density map
- ✓ seismic hazard map

8) Consider the geologic forces that have shaped the landscape in the study area and make a list, using the table below, of some of the geologic processes and/or forces that have likely influenced the study area. **For each geologic process and/or force that you list, you MUST provide evidence of specific landscape features from the maps that led you to your conclusion.**

Geologic process	Evidence	Expected sediment type(s)

9) For each of the geologic processes that you added to the table above, think about the sediment type(s)/characteristics that you would expect to be in the area as a result of the geologic process, and add that information to the table.

10) Next, look at the anthropogenic (human) influence on the landscape in the study area and list some of the infrastructure or land-use types that exist in the area.

11) Based on your responses to questions 8-10, make a list in the space below of the specific geologic, climatic, and anthropogenic characteristics in the study area that would contribute to increasing the driving forces (and thereby the mass-wasting potential) in the area.

12) All of the study areas from Unit 2 have experienced a major mass-wasting event somewhere in the map area. You have a blank copy of a hillshade image. On this image, select:

- ✓ 2 areas with high mass-wasting potential and color these areas in red
- ✓ 2 areas with medium mass-wasting potential and color these areas in yellow
- ✓ 2 areas with low (but still some) mass-wasting potential and color these areas in green

Ground rules:

- You may color the entire map if you like, but you must have a minimum of 2 high, 2 medium, and 2 low-risk areas.
- You must provide written evidence to justify the choices that you made. In other words, why did you characterize a particular area as high, medium, or low? Be as specific as possible.
- Note whether or not seasonality matters for the study area.