Diagnosing landslide hazard for infrastructure

Teaching Geomorphology
Cutting Edge Workshop

Submitted by Les Hasbargen, Assistant Professor
Earth Sciences Department
SUNY College at Oneonta
Oneonta, New York
Email: hasbarle@oneonta.edu
Phone: 607-436-2741

Description: In this field exercise, students make observations of a complex landslide which poses a hazard for nearby infrastructure. Students must record observations in the field in a field notebook. A report characterizing the landslide and the threat to infrastructure is required with an executive summary, an introduction to the problem, field investigation methods, the observations, and a rationale for remediation based on the observations.

Activity: Diagnosing landslide activity near infrastructure

1. *Problem*: Will the landslide create any problems for infrastructure?
2. *Setting*: An active, large active hillslope is required, preferably one close to infrastructure, and one which students can access safely. The following features are not uncommon, and make the problem richer: a river bend at the toe of the hillslope; a gas or water line routed through the slide; a hillslope exhibiting numerous scales of movements, from small debris flows a few cm wide to large rotational slides; and nearby infrastructure, such as buildings or roads.
3. *Approach*: Students must describe the general geology (kind of rocks, presence of faults), hydrology (springs and seepage faces), and topographic/geomorphic setting, such as hillslope steepness, nearness to road embankment or a stream, etc. Students gain experience with measuring landslide activity by determining the size of the movement(s) using field sketches and maps, and characterizing the level of activity, including some assessment of the age of the movement. Students are encouraged to take scaled photographs of key features of the hillslope to support their report.
4. *Evaluation*: Students are required to write a report summarizing the investigation. The report must have an executive summary, a description of the investigative methods, observations and evaluation of the hazard associated with the landslide, and a recommendation based on their observations for remedial action, if any. In addition, students must hand in a copy of their field notes for comments and evaluation. A rubric is handed out with the assignment awarding a range of points for how well the student performs the various tasks.
5. *Working in groups*: For larger classes, grading individual reports and field notes represents an overwhelming workload for the teacher. One way around this is to have all students take field notes, but then permit them to submit a joint report.

Susquehanna Landslide Investigation

Date: Thursday, September 27, 2007

Due: Hand in Thursday at the start of lab, October 4, 2007

Learning objectives:

1. Learn how to identify landslide features in a field setting and characterize the style of movement
2. Learn how to estimate the age or recency of activity of a landslide, and develop a prediction of future activity
3. Develop skills in writing a report on a field investigation

Key terms: landslide, scarp, toe, head, slump, seepage, bedrock, regolith, soil strength

Exercise:

You will investigate a landslide between Highway 7 and the Susquehanna River. You are acting as a consultant to a local road construction firm (Safe Cheap Roads Project—SCARP). They want you to verify that the road will not be affected by the landslide for the next 10 years. You must collect information to demonstrate the activity of the landslide, both in terms of its possible impact (size) and the likelihood of future activity.

Location: 42.4947º N, 74.98212º W

What to hand in:

1. Copies of your field notes
   a. Your field notes must contain all the observations that later turn up in your report. Document your observations with sketches, verbal descriptions, pictures, locations, etc.
2. A map of the landslide (must include title, scale, author, date created, reference to sources of information on the map, legend, map the landslide in relation to the river and the highway)
3. A 2-3 page report on your investigation. The report must contain the following sections:

a. Executive summary: a 1-2 paragraph statement which describes the purpose, location, and findings of your investigation, and a recommendation of a plan of action.
b. A section describing your observations. You should give a description of the geologic setting (bedrock and soils), the hydrologic setting, and the setting of the landscape. Your report should be able to answer the following questions: what cultural and natural features exist in the area? What is the bedrock? Is there a thick section of unconsolidated sediments underlying the landslide? Is groundwater playing a role in destabilizing the landslide? How long has the landslide been active? Is the landslide currently active? Is this landslide likely to be creeping, or when it moves, is it more likely to be catastrophic? Does the landslide threaten the road? Is there any evidence of ground deformation in the road pavement (tension cracks, etc)? Is the river playing a role in destabilizing the landslide? What evidence can you collect to help you answer these questions?
c. Recommendation based on your findings. This recommendation should be framed as to whether the landslide requires mitigation or not. Here you summarize your observations in support of your recommendation. If the landslide requires remediation, what course of action do you suggest? Does groundwater play a role? If so, perhaps draining of the landslide might stabilize it. Is the landslide restricted to a soil layer that is now mostly gone? If so, perhaps the activity is finished. Is bedrock contributing to the landslide instability? If so, a larger scale (and more expensive) mitigation strategy that stabilizes the bedrock must be proposed. Is the river influencing stability by removing material from the toe of the hillslope? If so, perhaps a curtain of rip rap at the toe of the slide to eliminate stream erosion might suffice to stabilize the landslide. Include an assessment of how the landslide moves, or might move, based on your observations and measurements, and a comparison to characteristics of mass movement types.

Grading Rubric For Field Investigation Report

Field notes: up to 5 pts

____sketches, pictures (0 = insufficient; 1 = adequate; 2 = excellent)

____verbal descriptions (0 = insufficient; 1 = adequate; 2 = excellent)

____legible, neat notes (0 = insufficient; 1 = adequate)

A map of the landslide: up to 5 pts (must include title, scale, author, date created, reference to sources of information on the map, legend, map of landslide in relation to the river and the highway)

Report appearance : up to 5 pts (for each, 0 = insufficient; 1 = adequate)

____Spelling

____Grammar

____Writing style

____Required report sections: Executive summary, data and observations, recommendations

____Neatness, design

Content necessary to the report (up to 14 pts)

____Must locate landslide (0 = insufficient; 1 = adequate)

____Must give size of landslide area (0 = insufficient; 1 = adequate)

____Must describe the geology of the hillslope (0 = insufficient; 1 = adequate, 2 = excellent)

____Must describe mass movement evidence (slumps, creep, surface runoff erosion) (0 = insufficient; 1 = adequate, 2 = excellent)

____Must place landslide into context: next to outside bank of bend in river (0 = insufficient; 1 = adequate; 2 = excellent)

____Must identify groundwater evidence: saturated zones, liquefaction features (0 = insufficient; 1 = adequate, 2 = excellent)

____Must characterize the overall level of landslide activity (0 = insufficient; 1 = adequate, 2 = excellent)

____Must recommend a course of action based on evidence (0 = insufficient; 1 = adequate, 2 = excellent)