Landslide activity 10: **Reducing risk from landslides**

Description: A classroom discussion focusing on reducing risk from landslides – minimizing personal risk and how communities reduce risk.

Materials: Overheads:
1. Possible methods of risk reduction
2. Signs of a potential landslide problem

Summary notes for classroom discussion
Student handout (Case studies)

Duration: one period

Teacher instructions:

1. First, ask the students if they think there is any risk of landslides (large or small) in their community. Their answers may change during the following discussions.
2. Explain the difference between HAZARD and RISK.
    - Hazard is simply the <u>likelihood</u> of an event occurring.
    - Risk considers not only the likelihood of an event, but also the possible <u>consequences</u> if the event did happen. Fatalities? Property damage? Economic losses? Therefore risk is greatest where the consequence for a population is greatest.
3. Lead a classroom discussion on how people can increase their personal safety. (See attached summary.)
4. Describe to the students some cases in which risk was reduced or eliminated. (See attached list of case studies.)
5. Lead a classroom discussion on how communities can reduce or eliminate risk of landslides. (See attached summary.)
6. In a final class discussion, students should:
    - decide if their community has a landslide risk and discuss where it may be
    - assess what criteria would be used to determine a landslide risk assessment for building construction , noting differences for houses, office buildings and roads
    - identify the appropriate land uses for risk prone areas
    - propose protective solutions to slope instability

Summary notes for classroom discussion:

How to protect your home against landslides

Although landslides usually occur without warning, understanding this natural hazard and following some sensible rules can help to protect your family and home.

a) Learn about your local geology and the potential for landslides in your area.

b) Avoid actions that would increase instability. For example, do not undercut a steep bank; do not build near the top or base of steep slopes; do not place fill on steep slopes; do not drain pools or otherwise increase water flow down steep slopes (see diagram).

c) Learn how to recognize signs of potential failure in your locality. Examples include slope cracks, slope bulges, unusual seepage of water on the slope, and small rock or sediment falls (see diagram).

d) Know who to notify if you recognize these signs (e.g. municipal emergency contact numbers and municipal engineers).

Minimizing the risks from landslides

Landslide risk can be minimized by various methods, including:

Avoidance: With expert input and careful planning, communities can identify unstable slopes and restrict or control development in hazard zones.

Protective measures: For communities that are already established, the municipal or provincial authorities must consider whether protective engineering measures or buy-outs and moving of people and buildings should be undertaken.

Engineered solutions: If unstable slopes cannot be avoided, there are numerous engineered solutions to deter landslides including:

a) improving drainage
b) reducing the angle of the slope
c) excavating to unload the top of the slope
d) building a protective berm or wall to buttress the bottom of the slope
e) containment or diversion structures

   Where landslides can neither be prevented nor avoided, a number of physical containment or diversion structures have been designed, including:

   - catchment dams and containment basins to control debris and water;
   - artificial channels or chutes to redirect debris flow;
   - nets and artificial walls to prevent falling rock or earth from hitting roads or structures

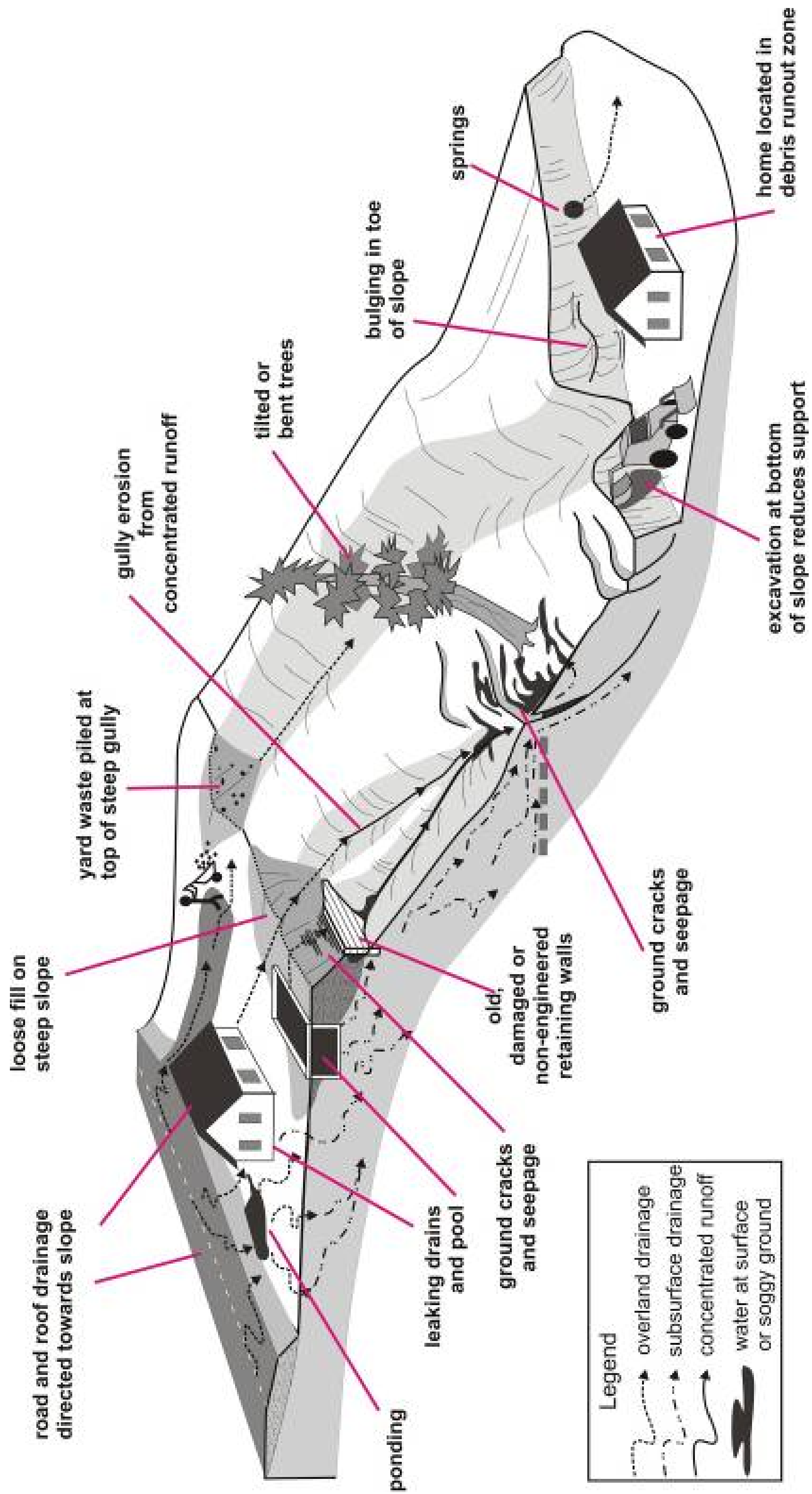
To help classroom discussion, a summary of possible methods of risk reduction is attached.

Possible methods of risk reduction

Alternative Methods	Advantages	Disadvantages
Do nothing	• none	• Risk remains
Relocate people	• Eliminates risk to life and to movable assets	• Expensive? • Public may be reluctant • Does not eliminate other impacts resulting from a future landslide (i.e. floods at a landslide dam, etc.)
Revegetate the slope	• Provides added stability when used in conjunction with structural methods • Reduces erosion on bank	• Not a primary method of stabilization
Change the slope	Excavation to reduce the angle of slope • Increases slope stability	• Requires excavation and disposal of a large volume of earth • Potential habitat damage • Expensive, if required for a large area
Stabilize the slope (engineering methods)	Geotechnical stabilization methods (retaining walls, rip-rap, berms, etc.) • increases slope stability and reduces erosion	• Visual impact • Potential habitat damage • Expensive, if required for a large area
Improve the drainage	Methods to improve internal and surface drainage of soil (drainage tiles, artificial ravines, etc.) • Increases slope stability • Reduces the level of the water table • Some methods also prevent slope erosion	• Expensive, may require large-scale earth moving • Requires maintenance • May also require other methods
Advanced Warning Alarm Systems	• May reduce risk to loss of life • Most effective for the properties that are furthest from the slope	• Risk to property remains • Installation and maintenance problems • Chance of false alarms causing public indifference • Is there time to evacuate?

Overhead 2

Signs of a potential landslide problem



Student handout 1

Case studies

Lemieux, Ontario – evacuation

Engineering studies, initiated following a large landslide on the South Nation River in 1971, concluded that the town of Lemieux lay within a zone of sensitive glaciomarine clay (Leda Clay) susceptible to large rapid earthflows. As a result, the town site was abandoned in 1991 and residents were relocated at the expense of the provincial government. On June 20, 1993, only two years later, a rapid earthflow consumed 17 hectares of farmland adjacent to the former town site. Through progressive headward failure, the landslide scarp retreated 680 m from the riverbank in less than an hour, most in the first 15 minutes. About 2.8 million m^3 of sand, silt and liquefied clay traveled 1.7 km upstream and 1.6 km downstream, completely blocking the river for several days. The direct and indirect costs related to this event were estimated at $12 500 000. However, because of evacuation of the former residents, no lives were lost.

The Charles Creek Catchment Dam – an engineered solution

The community of Strachan Creek, on Howe Sound, B.C., is built on a debris fan at the base of a steep slope. In the mid-1980s, a retention structure, designed to retain a debris flow event of 29,000 m^3, was constructed across Charles Creek to protect these homes. In the advent of a debris flow, coarse debris would be held in the basin behind the dam, while a riffled gateway in the dam would permit water to escape. In 2007, the Charles Creek catchment basin successfully contained a large debris flow that otherwise would have swept over the highway, railway, and several homes.

District of North Vancouver – hazard assessment and early warning system (also engineered solutions and expropriations)

A fatal debris flow in 2005 triggered an emergency response that has led to a new assessment of landslide risk in the District of North Vancouver. On January 19, 2005, a debris flow destroyed two homes at the base of the Berkley Escarpment. A state of emergency was declared and another 70 homes were temporarily evacuated. A hazard assessment was conducted along the escarpment and most problems were corrected. Drainage was improved, fill and retaining walls at the top of the slope were removed, and a catchment basin for debris flows was constructed. Eight houses that continued to present an unacceptable risk were expropriated. Lastly, an early warning system, based on critical rainfall thresholds, was developed for the District. An escalating scale of warning – Warning, Alert and Evacuation – will be issued as thresholds are reached.

Highway 97, British Columbia - an engineered solution

Highway 97, the major link between the cities of Kelowna and Penticton, British Columbia, was closed for almost three weeks in late October-early November, 2008, due to the imminent threat of a massive rock slide about 4 km north of Summerland. The highway closure, which normally averages 14,000 vehicles per day, caused great financial and logistical inconveniences to local industry, business and residents. The danger was first recognized on October 24, 2008, during a highway widening project, when a highway construction crew discovered a deep crack (up to 10 m deep at the rear) in a bedrock bluff overlooking the highway. The crack continued to widen at a rate of 8-15 mm per day, threatening to send 200 000 m^3 of rock crashing down onto the highway. A decision was made to reduce the mass of the upper slope, which was driving the movement, and to increase support at the lower slope. A series of small controlled blasts (varying from 1,000 to 17,000 m^3 of rock) was initiated, beginning at the top. The debris was transported down and placed along the base of the slope. Ultimately, a total of 34,000 m^3 of upper rock mass was removed and movement was stopped, although the slope continued to be monitored.