LANDSLIDES

in British Columbia

B.C. Ministry of Energy, Mines and Petroleum Resources

(Photo courtesy of the Geological Survey of Canada.)

Landslides in British Columbia

What do we mean by the word "landslide"? **Landslide** is a general term used to describe the down-slope movement of soil, rock and organic materials under the influence of gravity, and also the landform that results. British Columbia's steep, mountainous terrain, its complex geology, its high precipitation, both as rain and snow, its abundance of unconsolidated glacial sediments, and its geographic position astride the earthquake zone that surrounds the Pacific Ocean, all combine to make our province particularly susceptible to landslide activity. In fact, in British Columbia the loss of life and damage to property caused by landslides is greater than losses caused by other natural hazards such as earthquakes and flooding.

As our cities, towns, roads and highways steadily encroach onto steeper slopes and mountainsides, landslide hazards become an increasingly serious threat to life and property. However, by understanding the answers to the following questions, we may be able to lessen the effects of landslides.

- **What causes landslides?**
- **What are the different types of landslides?**
- **Where do landslides occur?**
- **How do landslides affect us?**
- **How can we minimize the effects of landslides?**

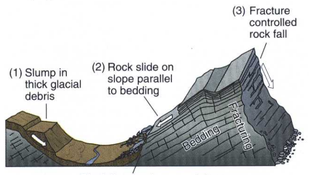
What causes landslides?

Some slopes are susceptible to landslides whereas others are more stable. Many factors contribute to the instability of slopes, but the main controlling factors are the nature of the underlying bedrock and soil, the configuration of the slope, the geometry of the slope, and ground-water conditions .

Three distinct physical events occur during a landslide: the initial slope failure, the subsequent transport, and the final deposition of the slide materials. Landslides can be triggered by gradual processes such as weathering, or by external mechanisms including:

- **Undercutting** of a slope by stream erosion, wave action, glaciers, or human activity such as road building,
- Intense or prolonged **rainfall**, rapid snowmelt, or sharp fluctuations in ground-water levels,
- Shocks or **vibrations** caused by earthquakes or construction activity,
- **Loading** on upper slopes, or
- A combination of these and other factors.

Once a landslide is triggered, material is transported by various mechanisms including **sliding**, **flowing** and **falling**. Landslides often occur along planes of weakness that may parallel the hill slope. In bedrock, planes of weakness are usually beds, joints or fractures. Soils such as silt and clay are weaker than rock and commonly have complex or multiple planes of weakness.



Types of weakness planes and associated landslides: (1) slope failure in glacial sediment resulting in slumps; (2) parallel bedding in rock causing slides; and (3) fracturing of rock promoting falls.

Effects of human activity

Landslides may result directly or indirectly from the activities of people. Slope failures can be triggered by construction activity that undercuts or overloads dangerous slopes, or that redirects the flow of surface or ground-water.

The Thuya Creek landslide near Little Fort occurred in 1972 and removed much of the roadway (photo courtesy of the Ministry of Transportation and Highways).

Poor road construction in this logged area near Boston Bar Creek probably contributed to slope failures in the early 1980s (photo courtesy of D. VanDine).

Poorly planned forest clearing may increase rates of surface water run-off or ground-water infiltration. Inefficient irrigation or sewage effluent disposal practices may result in increased ground-water pressures, which in turn can reduce the stability of rock and sediment.

People increase the risk of landslides by modifying the landscape, for example, by building on unstable slopes or in the path of potential landslides. Unfortunately, many people are unaware of their exposure to landslide risks.

How do landslides affect us?

Landslides cause property damage, injury and death and adversely affect a variety of resources. For example, water supplies, fisheries, sewage disposal systems, forests, dams and roadways can be affected for years after a slide event.

The negative economic effects of landslides include the cost to repair structures, loss of property value, disruption of transportation routes, medical costs in the event of injury, and indirect costs such as lost timber and lost fish stocks. Water availability, quantity and quality can be affected by landslides. Geotechnical studies and engineering projects to assess and stabilize potentially dangerous sites can be costly.

In 1991, a rock slide near Loggers Creek closed the Sea-to-Sky Highway for 12 days and cost $7 million for repairs and preventative structures (photo courtesy of the Ministry of Transportation and Highways).

A debris torrent at Britannia Creek in August of 1991 caused extensive damage to property (photo courtesy of K. Fletcher).

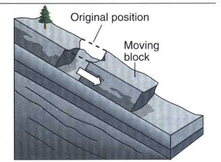
Landslide types

Landslides or slope movements can be classified in many ways. There are many attributes used as criteria for identification and classification, three are discussed below.

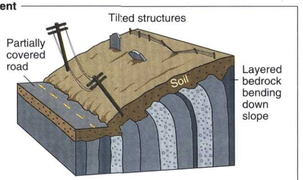
Rate of movement This ranges from very slow creep (millimetres/year) to extremely rapid (metres/second).

Type of material Landslides are composed of bedrock, unconsolidated sediment and/or organic debris.

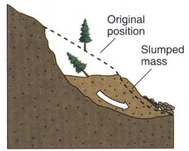
Nature of movement



Slide: movement parallel to planes of weakness and occasionally parallel to slope.

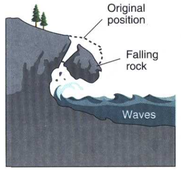


Creep: gradual movement of slope materials.

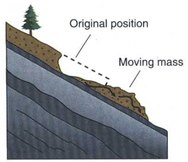


Slump: complex movement of materials on a slope; includes rotational slump.

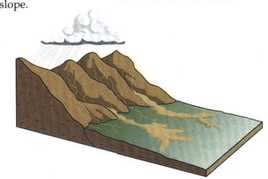
Topple: the end-over-end motion of rock down a slope.



Fall: material free falls.



Flow: viscous to fluid-like motion of debris.



Torrent: a sporadic and sudden channelized discharge of water and debris.

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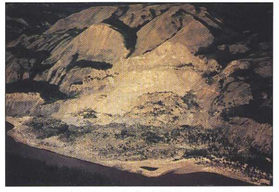
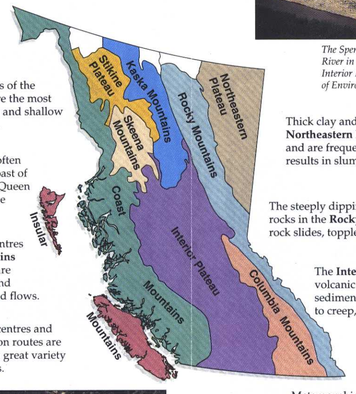
Where do landslides occur?

Some areas of British Columbia are more susceptible to landslides because of unique geological conditions.



The Spences Bridge Slide dammed the Thompson River in 1905 and is typical of other slides in the Interior Plateau (photo courtesy of the Ministry of Environment, Lands and Parks).



The sedimentary rocks of the **Skeena Mountains** are the most prone to large slumps and shallow slides in the province.

Debris flows and torrents often occur in the humid west coast of Vancouver Island and the Queen Charlotte Islands within the **Insular Mountains**.

Dormant volcanic centres in the **Coast Mountains** (*e.g.*, Mt. Garibaldi) are susceptible to rock and debris avalanches and flows.

Population centres and transportation routes are exposed to a great variety of landslides.

Thick clay and silt-rich glacial sediments in the **Northeastern Plateau** are prone to soil creep and are frequently undercut by rivers, which results in slumps.

The steeply dipping beds of sedimentary rocks in the **Rocky Mountains** are prone to rock slides, topples, falls and avalanches.

The **Interior Plateau** contains weathered volcanic rock and glaciolacustrine sediments that are particularly susceptible to creep, slumping and sliding.

Metamorphic rocks in the **Columbia Mountains** are prone to rock slides and slumps.

(Map modified from Geological Survey of Canada 1701A.)

This structure near Williams Lake received considerable damage in 1992 from undercutting of the slope (photo courtesy of the Ministry of Health).

Historical Landslides in British Columbia

Date	Name/Location	Type	Comments
1855–56	Rubble Creek/Garibaldi (The Barrier)	Rock avalanches	30 million cubic metres of rock dislodged
1880	Haney Slide	Clay slide	Displacement wave 12 metres high created by the slide caused 1 death
1888	Ashcroft	Silt slide	15 million cubic metre slide blocked Thompson River for 2 days
1898	Big Slide/Quesnel	Sediment slump-flow	Damaged homes, farms and a highway
1905	Spences Bridge/Thompson River	Silt slump	Resulting wave caused 18 deaths
1914	Hell's Gate/Thompson River	Rock fall	Millions of dollars in lost fish stocks and in repair of fish migration corridor
1915	Jane Camp/Britannia Mine	Rock avalanche	200 000 cubic metres of rock; 56 deaths
1921	Britannia Creek/Howe Sound	Debris torrent	37 deaths
1931	Meager Creek/Pemberton	Debris flow	Glacial dam burst, over 5 million cubic metres of water and debris
1957	Prince Rupert	Debris flow	Debris 17 metres thick; 7 deaths
1965	Hope Slide	Rock slide	British Columbia's largest rock slide; 4 deaths
1968	Camp Creek/Revelstoke	Debris torrent	76 000 cubic metres of debris; 4 deaths
1970	Summerland	Silt fall	1 death
1971	Boston Bar/Fraser River	Slump	Train derailed in slump; 3 deaths
1972	Sparwood	Debris flow	Mine waste movement; 2 deaths
1973	Attachie Slide/Fort St. John	Clay slump	Over 24 million cubic metres of sediment
1973 & 75	Port Alice	Debris torrent	2 events, 22 000 cubic metres
1975	Devastation Glacier	Rock avalanche	13 million cubic metres; 4 deaths
1981	M Creek/Howe Sound	Debris torrent	20 000 cubic metres of debris; 10 deaths
1983	Alberta Creek/Howe Sound	Debris torrent	15 000 cubic metres of debris; 2 deaths
1990	Philpott Road/Kelowna	Debris flow	Heavy rain; 3 deaths
Ongoing	Wahleach/Lower Fraser Valley	Creep	60 million cubic metres, $25 million on engineering controls
Ongoing	Downie/Revelstoke	Rock slide, slump	Millions spent to control more than 2 billion cubic metres of rock

The Attachie slide of May 26, 1973 west of Fort St. John dammed the Peace River for approximately 10 hours (photo courtesy of Thurber Engineering Ltd.)

In 1898, the Big Slide of Quesnel destroyed homes, farms and part of a highway (photo courtesy of the Ministry of Transportation and Highways).

Landslide losses

Large, infrequent landslides contribute less to personal and property losses than do the smaller, more frequent slides and debris torrents in populated areas of British Columbia.

The Vancouver to Squamish highway has been affected by 14 major debris torrents since 1906. Twelve lives have been lost and 11 bridges, 4 homes and numerous structures have been damaged or destroyed. Not one of these 14 slide events was larger than 20 000 cubic metres (photo courtesy of the Ministry of Transportation and Highways).

The Hope slide, 18 kilometres east of Hope, was one of the largest slides in Canadian history. The southwestern slope of Johnson Peak, collapsed on January 9, 1965, spreading 47 million cubic metres of debris, 85 metres thick, over a 3 kilometre stretch of the Hope-Princeton highway. The slide occurred in an unpopulated area in early morning hours and resulted in four deaths (photo courtesy of the Ministry of Environment, Lands and Parks).

How can we minimize the effects of landslides?

The Role of the Geoscientist and Engineer:

- Landslide risk can be reduced with engineering and geoscience investigations that lead to improved community bylaws and zoning. The British Columbia *Municipal Act* contains legal requirements that deal with landslides and other hazards.
- By geological mapping, detecting slope hazards and determining the likelihood of landslide occurrence, geoscientists can assist engineers, developers, planners and building inspectors in avoiding high-risk areas. Through this process, structures such as homes, schools, hospitals, power-lines, fire stations and roads can be safely located away from potential landslide risk areas.

Your Role:

- Learn more about your local geology and the potential geologic hazards in your area.
- Consult an engineer or geoscientist with relevant experience in landslide work for advice or information on specific hazards and potentially hazardous locations.
- Avoid activities that result in the undercutting of steep banks, and avoid the construction of buildings near the top or base of steep slopes. Do not place fill on steep slopes.
- Request information and assistance from your municipal or district planner or building inspector prior to land purchase, prior to sub-dividing, and prior to construction applications.

Property damage in the Qualicum Beach area after a landslide (photo courtesy of the Ministry of Environment, Lands and Parks).