



**GEOLOGICAL SURVEY OF CANADA  
OPEN FILE 7073**

**New Canadian Teaching Resources from Natural Resources  
Canada for Earthquakes, Landslides and Tsunamis (lesson  
plans, maps and event timelines) (January 2012)**

**J.M. Aylsworth**

**2012**



Natural Resources  
Canada

Ressources naturelles  
Canada

**Canada**



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## Geological Hazards

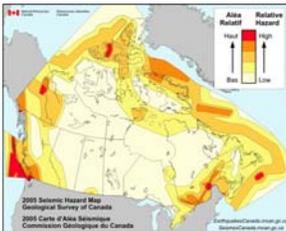
A **natural hazard** can be described as the threat of a potentially damaging process or phenomenon that occurs, or has the potential to occur, in our physical environment. The hazard exists whether or not an event has happened. A natural hazard becomes a **natural disaster** when an event occurs that causes injuries and damages beyond society's ability to cope.

A **geological hazard** is a natural hazard that has a geological or physiographic cause, trigger or effect. Canada is vulnerable to a number of natural hazards including earthquakes, landslides, tsunamis, volcanic eruptions, floods and melting permafrost.

Geological hazards can rarely be stopped, but careful land-use planning, robust building codes, engineered mitigation structures, and personal preparedness can reduce the risk of loss.

- **Earthquakes**
- **Landslides**
- **Tsunamis**

### Earthquakes



Map of seismic hazard

An earthquake is the rapid shaking of the Earth's surface that follows the sudden release of energy within the Earth. Each year, more than 3500 earthquakes in or near Canada are recorded and located by seismologists. Since most earthquakes are very small and many occur in unpopulated areas, only about 50 earthquakes each year are reported by the Canadian public. Most earthquakes that can be felt are too small or too remote to cause damage. In the entire twentieth century, only about 20 earthquakes have caused significant damage in this country.

Although seismologists are unable to predict when large earthquakes are going to occur, they are able to look at geological evidence and historical patterns of seismic activity to determine where future earthquakes are most likely to occur. This information is used to develop seismic hazard models, which provide the design requirements for the National Building Code of Canada. The building code helps to ensure that buildings are constructed as earthquake resistant as possible. Individuals can help to reduce the effect of an earthquake by checking with local emergency management organizations to understand the risks in their region. Make a plan so that you know what to do in case of an earthquake and prepare an emergency kit to help you and your family survive for 72 hours.

#### For more information:

Geological Survey of Canada: Earthquakes <http://earthquakescanada.nrcan.gc.ca/>

1.1 Atlas of Canada: Earthquakes [PDF] - included as part of these resources

Public Safety Canada <http://www.getprepared.gc.ca/fl/rthqks-eng.pdf>

## Landslides



Map of areas vulnerable to landslides

A landslide is the downslope movement of sediment and rock. Landslides can be found in any part of Canada, even in areas with very little relief. They happen in bedrock or in loose sediment; on land or under water; may be large or small, rapid or slow, and generally occur without warning. There is a wide variety of failure mechanisms and triggering causes, and local geological and topographical conditions determine which type of landslide may happen in a specific region. Some regions are particularly susceptible to landsliding: steep slopes in the mountains; weak cretaceous bedrock along valleys in the Prairies; and valleys eroded into fine-grained sediments in areas once covered by glacial lakes and glacial seas.

Impact is greatest where landslide occurrence coincides with human activity. In the historical period (taken to be post-1840), landslides in Canada have resulted in over 600 fatalities, including the destruction of several communities, and caused billions of dollars in damage. The hazard presented by landslides involves not only failure of ground beneath a structure and impact or burial by moving debris, but also secondary effects such as landslide-dammed floods and landslide-generated waves. However, although landslides will continue to occur annually, landslide risk in our lives can be reduced or eliminated with proper planning and mitigation action.

### For more information:

**1.2 Atlas of Canada: Landslides [PDF]** - included as part of these resources  
Public Safety Canada <http://www.getprepared.gc.ca>

## Tsunamis



Map of tsunami hazard zones for Southwestern British Columbia

A tsunami is a sea wave or series of waves produced by large disturbances of the sea floor that are of relatively short duration. Such disturbances cause the water column to move vertically and the resulting wave energy to spread outwards across the ocean surface at high speed. Although tsunami occurrences in Canada are rare, they do occur and can cause major damage and loss of life. Since the beginning of the twentieth century, there has been one tsunami reported about every fifteen to twenty years in Canada.

Although it is impossible to prevent a tsunami, it is possible to estimate the tsunami risk for coastal communities. Certain actions can be taken to lessen the effects of tsunamis (for example, land-use controls such as zoning, relocation, and property acquisition). Other means of protecting coastal areas at risk are emergency preparedness, dyking, barrier construction, flood proofing, tsunami-resistant construction, warning systems including signage, and public education.

### For more information:

**1.3 Atlas of Canada: Tsunamis [PDF]** - included as part of these resources  
Public Safety Canada <http://www.getprepared.gc.ca>

## Teacher Resources

These teacher resources provide a set of educational tools to raise awareness and heighten understanding of geological hazards in Canada. The activities strive to support teachers in the successful delivery of Science and Geography curriculum expectations while challenging students to relate the knowledge they have acquired to the world outside their classroom.

- [Disaster Maps](#)
- [Disaster Timelines](#)
- [Presentations](#)
- [Lesson Plans](#)

### Disaster Maps

These are page-size maps, showing Canadian disasters. Events are consecutively numbered by date; compatible with the disaster timelines.

- [2.1 Earthquakes \[PDF\]](#) The earthquakes map shows the epicentre and the area of strong shaking for Canadian earthquake disasters as well as for earthquakes that caused significant damage, were widely felt, or were scientifically significant.
- [2.2 Landslides \[PDF\]](#) The landslides map shows Canadian landslide disasters that have caused 5-19, 20-49, and 50 or more fatalities.

### Disaster Timelines

Timelines are presented as a graphic and as a list. The graphic depiction spreads over 2 pages. Information includes date, location and impact. Events are consecutively numbered by date; compatible with the Disaster Maps.

- **Earthquakes timeline:** [3.1 Graphic \[PDF\]](#), [3.2 List \[PDF\]](#) Canadian earthquakes of magnitude  $\geq 5$  that have had significant impact.
- **Landslides timeline:** [3.3 Graphic \[PDF\]](#), [3.4 List \[PDF\]](#) Canadian landslides with  $\geq 5$  fatalities.
- **Tsunamis timeline:** [3.5 List \[PDF\]](#) Tsunami events that have impacted Canada.

### Presentations

The "PowerPoint" Presentations are accompanied by notes for the teacher.

- [4.1 Earthquakes \[PDF\]](#), [4.2 Accompanying notes\\_Earthquakes \[PDF\]](#) An introduction to plate tectonics and earthquakes, including seismic waves, magnitude and intensity, the impacts, the 2010 Haitian and Chilean earthquake and the 2011 Japan earthquake examples, earthquakes in Canada, and how you can increase your personal preparedness.
- [4.3 Landslides in Canada \[PDF\]](#), [4.4 Accompanying notes\\_Landslides in Canada \[PDF\]](#) An introduction to Canadian landslides including landslide types and characteristics, where they occur in Canada and why, the impacts, disaster cases, and how you can increase your personal preparedness.

### Lesson Plans

The following lesson plans offer a general introduction to the geological hazard, with a focus on Canadian examples, for elementary and secondary school classes. Each lesson contains teaching notes (with answers), maps and diagrams suitable for overhead projection, and student activities and worksheets.

- [Earthquakes](#)
- [Landslides](#)
- [Tsunamis](#)

### Earthquakes

**Description:** A group of lesson plans offering a general introduction to earthquakes, including instructions for teachers, teaching notes, exercises, word games, student research activities, damage assessments, and creative writing tasks, with an emphasis on Canadian examples. Assorted grade levels.

- [5.1 Introduction to Earthquakes \[PDF\]](#) An introduction to earthquakes for junior elementary students, including questions for class discussion, easy demonstrations, map analysis, and finishing with an earthquake safety drill. Grades 3 to 5.

- 5.2 Creative Essay [PDF]** Students write a ‘newspaper article’ describing an earthquake, written as if they were there at the time of the event. Grades 3 to 5.
- 5.3 Introduction to Earthquakes [PDF]** A teacher-led lesson introducing earthquakes, including cause, seismic waves, magnitude and intensity, and where they commonly occur. The lesson involves classroom discussion, map analysis and a brief lab demonstration. Grades 7 to 9.
- 5.4 Earthquake Vocabulary Game [PDF]** Crossword puzzle, using earthquake terminology. Grades 7 to 9.
- 5.5 Design an Informative Brochure on Earthquakes and Safety [PDF]** Students create a brochure about earthquakes, focusing on advice on how to increase personal safety. Grades 6 to 8.
- 5.6 Earthquakes in Canada [PDF]** A student research activity that explores the Earthquakes Canada website to answer questions about Canadian and local earthquakes. Grades 7 to 12.
- 5.7 Locate the Earthquake Exercise [PDF]** Students learn to read a seismogram and calculate the epicentre of a Canadian earthquake. Teachers can choose a seismogram package from eastern or western Canada. Grades 7 to 12.
- 5.8 Earthquake Quiz [PDF]** Independent reading and quiz. Students will read about earthquakes in Canada and then complete a quiz of true or false, or multiple choice questions. Grades 9 to 12.
- 5.9 Earthquake Damage and Earthquake Preparedness [PDF]** A student research activity on earthquake hazards and ways to reduce risk, culminating in group presentations to the class. Grades 9 to 12.

## Landslides

**Description:** A group of lesson plans offering a general introduction to landslides, including instructions for teachers, teaching notes, lab demonstration, word games, student research activities, damage assessments, and creative writing tasks, with an emphasis on Canadian examples. Assorted grade levels.

- 6.1 Introduction to Landslides [PDF]** Teaching lesson using the Landslides in Canada “PowerPoint” [PDF] presentation and accompanying notes. Grades 7 to 12.
- 6.2 The Frank Slide [PDF]** A junior elementary school activity (Grades 3 to 5) including a word search puzzle, a map exercise, a classroom discussion, and a creative writing assignment on the historic Frank Slide, the worst landslide disaster in Canada.
- 6.3 Make a Debris Flow [PDF]** This lab demonstration is an easy and fun way to effectively produce a model debris flow landslide in the classroom. It can be used once as a simple demonstration or can become an experiment comparing the results of different slope angles and different sediment textures. Suitable for all grade levels.
- 6.4 Landslides in Eastern Canada – Earthflows [PDF]** This lesson consists of a presentation of how and why landslides occur in sensitive clays of eastern Canada, followed by a choice of activities where students can complete a vocabulary game, label a diagram of an earthflow, or identify the zone at risk of landslides and decide where to locate a new hospital. Grades 7 to 9.
- 6.5a Landslide Quiz [PDF]** 13 multiple choice or true/false questions on landslides in Canada for intermediate level students - Grades 7 to 9.
- 6.5b Landslide Quiz [PDF]** 20 multiple choice or true/false questions on landslides in Canada for Grades 11 and 12.
- 6.6 Landslides in Canada – History of Disasters [PDF]** This activity teaches students to use a database to graph and analyze landslide disasters in Canada. It is followed by a classroom discussion. Grades 7 to 12.
- 6.7 Prairie Landslides [PDF]** This lesson includes map interpretation, topographic cross-sections, and discussion of landslides along river valleys in the Prairies. Grades 7 to 12.
- 6.8 Debris Flows in British Columbia [PDF]** Students discover the relationship between weather conditions and landslides by graphing and analyzing precipitation and runoff data prior to historic debris flow landslides. This lesson could be used independently, or could follow the lab demonstration to model a debris flow. Grades 11 and 12.

**6.9 Landslides in Eastern Canada [PDF]** A teaching lesson about the landslide potential of the sensitive marine clay (Leda Clay) of eastern Canada and a student activity. Students calculate the depth of potential failure along a river using real data. Using geological logs obtained from borehole coring, students evaluate landslide hazard along a fictional river valley, determining the most hazardous and the safest areas. Grades 11 and 12.

**6.10 Reducing Risk from Landslides [PDF]** A classroom discussion focusing on reducing risk from landslides – minimising personal risk and how communities reduce risk. Grades 9 to 12.

## Tsunamis

**Description:** A group of lesson plans offering a general introduction to tsunamis, with an emphasis on tsunami hazard along Canadian coasts. Lessons include teaching notes (with answers), lab demonstrations, maps and diagrams suitable for overhead projection, damage assessments, emergency preparedness and student research activities. The basics are taught in lessons 1 or 7; the other activities are optional. For senior elementary and secondary school.

**7.1 Introduction to Tsunamis [PDF]** A teaching lesson, including facts, explanations, vocabulary, diagrams suitable for overhead projection, and links to on-line resources. This activity provides the background for the following activities, which are optional. Grades 6 to 8.

**7.2 Tsunami Demonstration [PDF]** A short lab demonstration of tsunami waves. Grades 6 to 8.

**7.3 Tsunami vocabulary [PDF]** A crosswords puzzle, word match game, and diagram exercise, to help students learn tsunami terminology. Games may also be used as a test quiz. Grades 6 to 8.

**7.4 Creative essay [PDF]** A 'newspaper article' about either the Grand Banks or the Port Alberni tsunami disaster, written as if they were there at the time of the event. Grades 6 to 8.

**7.5 Tsunami Damages [PDF]** Students assess the possible damages that might occur if a tsunami struck a Canadian community of their choice. Grades 6 to 8.

**7.6 Design a Tsunami Brochure [PDF]** Students design and create a brochure about tsunamis, including advice on increasing personal safety. Grades 6 to 8.

**7.7 Introduction to Tsunamis [PDF]** An introduction to tsunami waves and tsunami hazard in Canada, followed by a student activity involving calculations of wave velocity, amplitude and travel time and explanation of the results. Grades 9 to 12.

**7.8 Create a Tsunami Model [PDF]** A hands-on lab experiment, designed and conducted by students, to generate and measure tsunami waves and prepare a scientific report. This is followed by a classroom demonstration and discussion. Grades 9 to 12 (adaptable to Grades 6 to 8).

**7.9 Exploring the Damages of the 1929 Grand Banks Tsunami [PDF]** A mapping and database activity that explores the damages associated with the Grand Banks Tsunami that struck Newfoundland in 1929. Grades 9 to 12.

**7.10 Tsunami Warning System [PDF]** Introduction to tsunami warnings, followed by a hands-on activity to calculate velocity, amplitude and travel time of an earthquake-induced tsunami and preparation of a tsunami warning notice. The lab is written for Prince Rupert but it can be easily changed to any coastal community in British Columbia. Grades 9 to 12.

**7.11 Emergency Preparedness Plan [PDF]** Students research and create an emergency preparedness plan for Port Alberni. Grades 9 to 12.

**7.12 Design an Informative Brochure on Tsunamis and Safety [PDF]** Students create a brochure about tsunamis, including advice on how to increase personal safety. Grades 9 to 12.

**7.13 Tsunami vocabulary crossword puzzle [PDF]** A crossword puzzle to help students to learn tsunami terminology. Grades 9 to 12.

**7.14 Tsunami Quiz [PDF]** Twenty multiple choice or true/false questions on tsunamis. Grades 9 to 12.