



Geoscape Ottawa-Gatineau

Grade 7 Lesson Plans to accompany the Geoscape Ottawa-Gatineau poster and website
F. Fiset and J. Aylsworth

Theme Nine: Landslides

List of Expectations		
Grade	Strand and Topic	Expectations
7	Science: Earth and Space Systems The Earth's Crust	<ul style="list-style-type: none"> identify the factors that must be considered in making informed decisions about land use and explain their importance explain the causes of some natural events that occur on or near the earth's surface and their effects
7	Geography: Patterns in Physical Geography	<ul style="list-style-type: none"> demonstrate an understanding of how physical patterns affect human activity

Overview

The Geoscape "Landslides" theme consists of lessons which will enable students to recognize the relationship between geology and landslides, the landslide hazard in the Ottawa-Gatineau area, and the importance of land use management when dealing with Leda clay.

At the end of these lessons, students will be able to:

- recognize the risks of landslides in the Ottawa-Gatineau area
- understand the properties of Leda Clay and how landslides occur
- appreciate the short interval of time in which landslides take place

Suggested Lessons	Brief Description
Students Take Notes	Landslides: The Earth can move
Key Word Game	Word Match Game
Lesson 1	"Anatomy of a landslide" presentation and worksheet
Lesson 2	Hazard zone
List of related web sites and resources	<p>Canada Landslides Project, Geological Survey of Canada: information, explanations, case histories, interactive maps and databases http://landslides.nrcan.gc.ca/</p> <p>Urban Geology of the National Capital Area: landslides are shown on the map of surficial deposits. http://gsc.nrcan.gc.ca/urbgeo/natcap/surf_introduction_e.php .</p> <p>Norwegian Geotechnical Institute website has two video clips of the famous Rissa landslide in action. This type of landslides also occurs in the Ottawa area. http://www.ngi.no/english/default.asp?action=showarticle&artid=6AF823C033724E43A7DA8646C5EF13ED</p>

Students take notes:

Landslides: The Earth Can Move

Recipe for Trouble

Leda Clay (Ottawa's "Quick Clay")

- potentially unstable material may act like a liquid (liquefy) when disturbed
- underlies much of Ottawa-Gatineau area
- was formed by fine sediment particles settling to the bottom of the Champlain Sea at the end of Ice Age
- source of particles: clay and silt size particles ground (eroded) from bedrock by glaciers and transported
- particles ultimately washed into Champlain Sea
- fine sediment settled slowly to the bottom
- salt (sea water) helped attract particles together in clusters as they fell through the sea
- no more sea
- over time, salt leached away, removing the bond between particles
- today, the resulting sediments are weak, but rich in water content
- landslides are possible if clay is disturbed

What can trigger a landslide?

- river erosion
- high rainfall (affects rivers)
- rapid snowmelt (affects rivers)
- earthquakes
- human activities

Leda clay landslides are called EARTHFLOWS.

- Move as a flow of "liquefied" mud
- Very rapid
- Can destroy relatively flat land
- Can flow great distances

Students take notes:

Landslides: The Earth Can Move

Unstable Clay Slopes

Over 250 landslides have been recorded within 60 km of Ottawa

Impact of these landslides:

- injuries and some deaths (Town of Notre-Dame-de-la-Salette was destroyed in 1908)
- property damage, infrastructure damage
- debris dams rivers and causes flooding, siltation and water contamination

To reduce risk:

- identification of potential sites by geologists and geotechnical engineers
- landuse zoning regulation to avoid risk
- protective engineering at possible landslide sites to control risk

Key word game: Match the word with its definition

name:

Landslides

- | | | |
|--------------------|-------|---|
| 1. catastrophic | _____ | A. the dispersal of fine particles (silt) within water during transportation |
| 2. framework | _____ | B. the process of turning into a liquid |
| 3. unstable | _____ | C. description of a sudden violent change |
| 4. sensitive clay | _____ | D. material that has moved in a landslide. |
| 5. geologist | _____ | E. group of 'things' gathered closely together |
| 6. debris | _____ | F. a strong force holding or joining things together |
| 7. siltation | _____ | G. to slowly pass through or into something |
| 8. cluster | _____ | H. informal name for a sensitive marine clay commonly found in the St. Lawrence Lowland |
| 9. Leda clay | _____ | I. when disturbed, it may lose its strength, turn into a liquid mud, and flow as a landslide |
| 10. slope | _____ | J. low area where contents have been removed |
| 11. bedrock | _____ | K. the supporting structure |
| 12. excavation | _____ | L. fine grain size mid-way between sand and clay |
| 13. clay | _____ | M. sediment formed of clay-sized particles |
| 14. dam | _____ | N. something that is likely to change |
| 15. susceptible | _____ | O. to be located below something |
| 16. infrastructure | _____ | P. likely to be affected or influenced by a process or event |
| 17. landslide | _____ | Q. basic facilities (i.e. transportation, power, and communication lines, and water supply, power plants, etc.) |
| 18. erosion | _____ | R. the process of something wearing away |
| 19. infiltrate | _____ | S. solid rock exposed at the surface or underneath soil and loose sediments |
| 20. bonding | _____ | T. one who understands and investigates the physical processes, structure, and history and materials of the Earth |
| 21. silt | _____ | U. sediment or rocks that become detached and move downslope |
| 22. underlie | _____ | V. inclined surface, measured as a change in elevation of a surface over a specific distance |
| 23. liquefy | _____ | W. barrier across a river that can stop water flow |

Key word game solutions

Landslides

1. catastrophic C
2. framework K
3. unstable N
4. sensitive clay I
5. geologist T
6. debris D
7. siltation A
8. cluster E
9. Leda clay H
10. slope V
11. bedrock S
12. excavation J
13. clay M
14. dam W
15. susceptible P
16. infrastructure Q
17. landslide U
18. erosion R
19. infiltrate G
20. bonding F
21. silt L
22. underlie O
23. liquefy B

9.1 Lesson 1: Anatomy of a Landslide

Brief Description

This lesson consists of a brief presentation of how landslides occur, followed by an activity where students can label a diagram of the “Anatomy of a Landslide”.

Suggested Materials

Overhead projector or LCD projector

Overhead of “Failure Sequence” and “Landslides in Leda Clay of the Champlain Sea” or web page:

http://geoscape.nrcan.gc.ca/ottawa/landslides_e.php

student worksheet

Duration 20 minutes

Lesson Instructions

1. Using the overhead “Failure Sequence”, explain each step involved in a Leda clay earthflow.
2. Discuss the impact of landslides on buildings, humans, and wildlife and on river systems.
3. Ask students: “What would you do if a scientist told you that your house is built on Leda clay? (Note: Not all the clay is unstable. The site must be tested.)
4. Present the overhead of map “Landslides in Leda Clay of the Champlain Sea”
5. Point out the three main rivers (Ottawa, Gatineau and Rideau)
6. Ask students if they see a pattern of where landslides tend to occur (1. in area covered by Champlain Sea, 2. near rivers, although they can occur on other slopes). Have students suggest reasons why they tend to occur near rivers (erosion of the riverbank, slope of land, etc.)
7. Distribute the worksheet and have students label the diagram with the numbers corresponding to each step in the failure.

Student Worksheet (Answers)

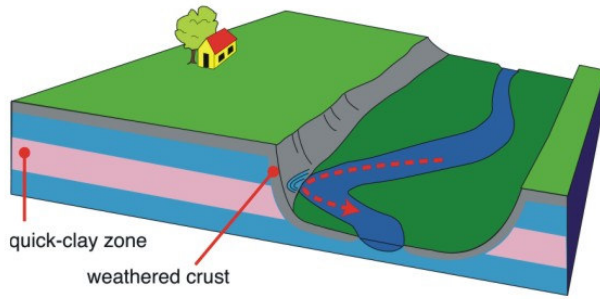
3. Quick-clay (sensitive clay) zone

7. Weathered crust

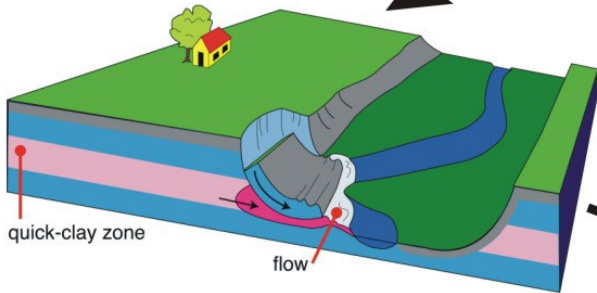
1. Firm weathered crust is eroded by river or weakened ground shaking and a small landslide happens at the slope
5. Sensitive clay underneath liquefies and is no longer able to support itself and flows away from the landslide scar
4. This triggers a “domino effect” causing many “slices” to fail, one after another. The original flat land gets “eaten away” as the ground turns into flowing mud
2. Solid blocks of ground may be carried away on the flowing mud
8. The flowing mud moves far away from the landslide scar and the mud may fill the valley
6. Landslide mud (debris) dams (blocks) rivers, causing flooding in the valleys.

Failure Sequence

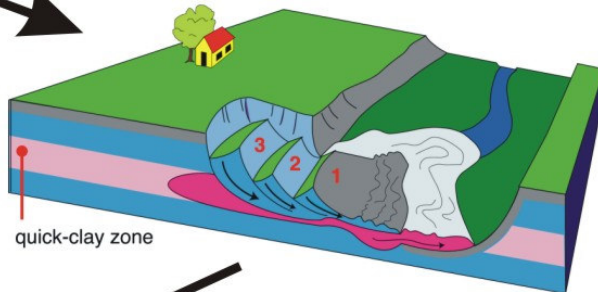
Trigger Scenario: Toe Erosion



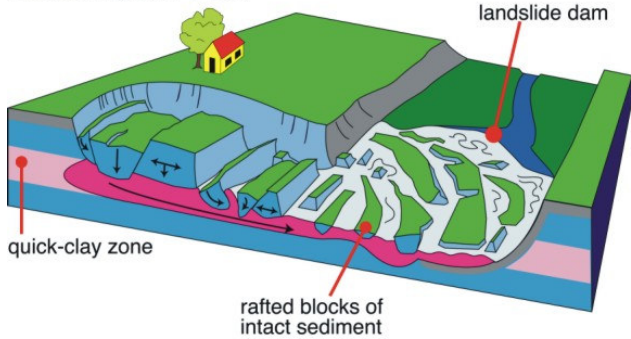
Rotation and Flow



Retrogressive Failure

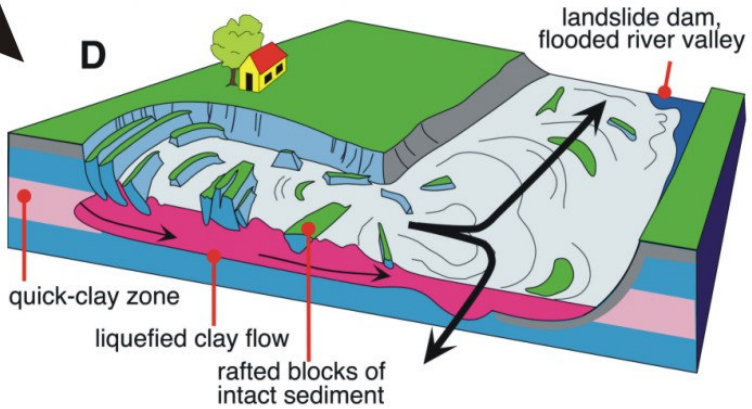


Lateral Spreading and Subsidence, Rotation, and Flow

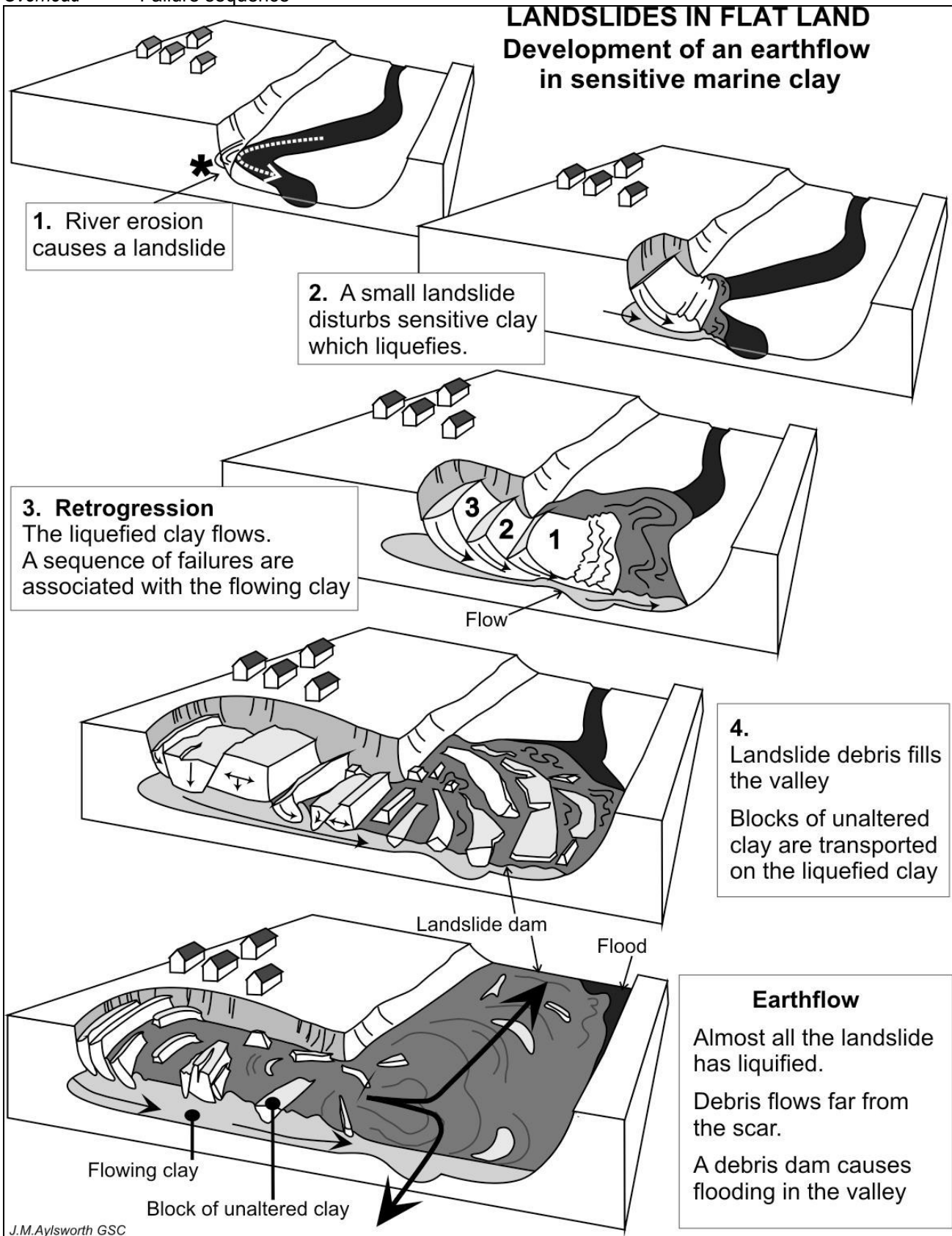


Earthflow

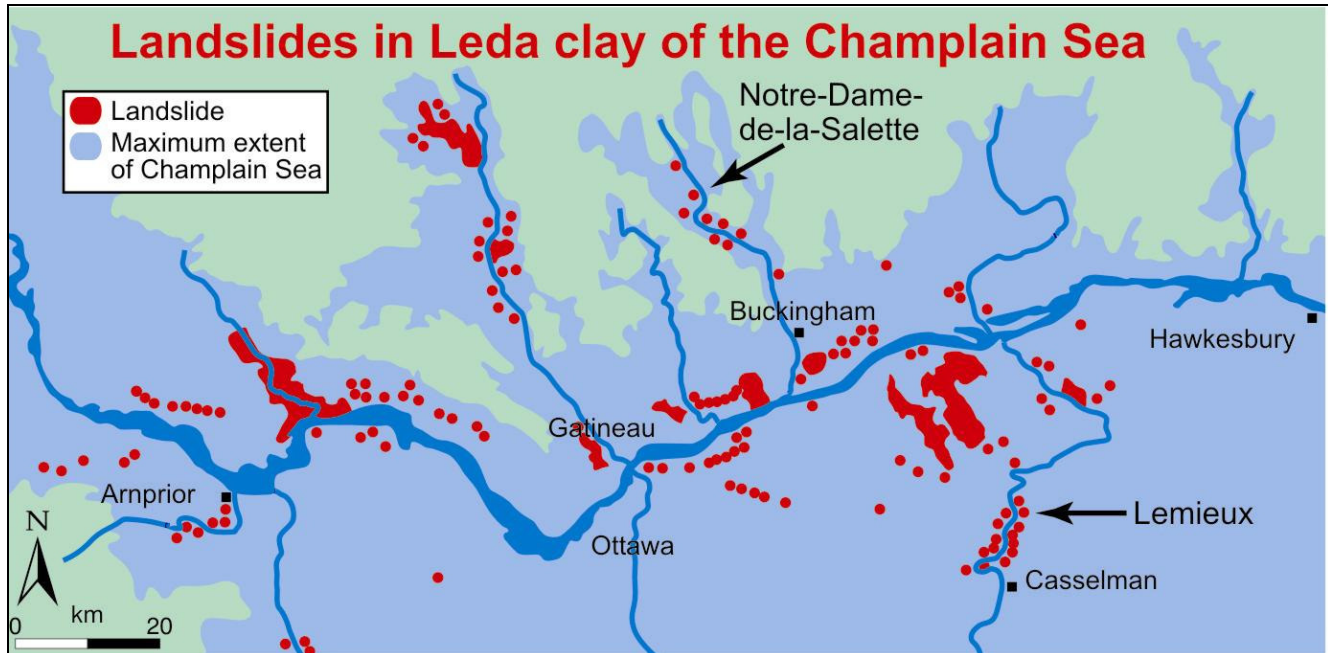
'Lemieux type' Sensitive Clay Flow



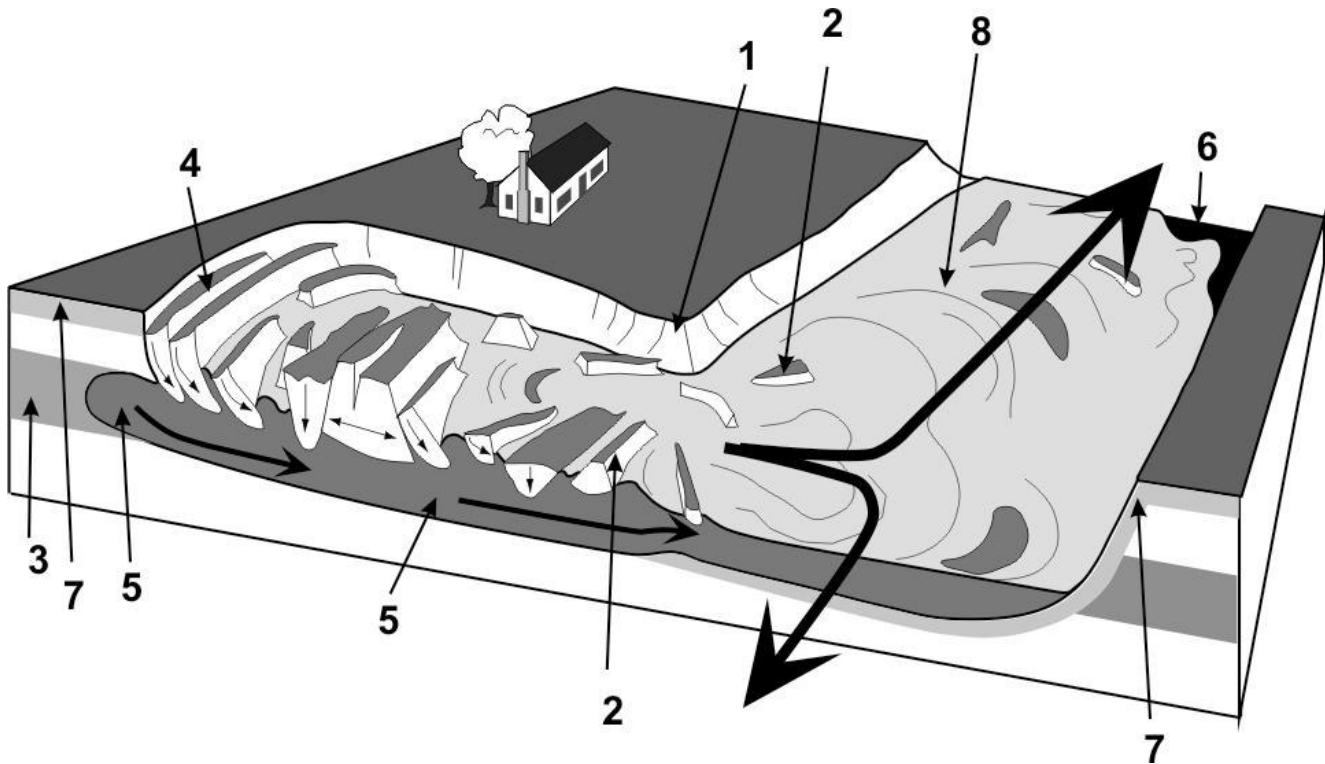
LANDSLIDES IN FLAT LAND
Development of an earthflow
in sensitive marine clay



J.M.Aylsworth GSC



Label the 'Anatomy of a Landslide' diagram



_____ Quick-clay (sensitive clay) zone

_____ Weathered crust

_____ Firm weathered crust is eroded by river or weakened ground shaking and a small landslide happens at the slope

_____ Sensitive clay underneath liquefies and is no longer able to support itself and flows away from the landslide scar

_____ This triggers a “domino effect” causing many “slices” to fail, one after another. The original flat land gets “eaten away” as the ground turns into flowing mud

_____ Solid blocks of ground may be carried away on the flowing mud

_____ The flowing mud moves far away from the landslide scar and the mud may fill the valley

_____ Landslide mud (debris) dams (blocks) rivers, causing flooding in the valleys.

9.2 Lesson 2: Hazard Zone

Brief Description

Students must identify the zone at risk of landslides and decide where to locate a new hospital.

Suggested Materials

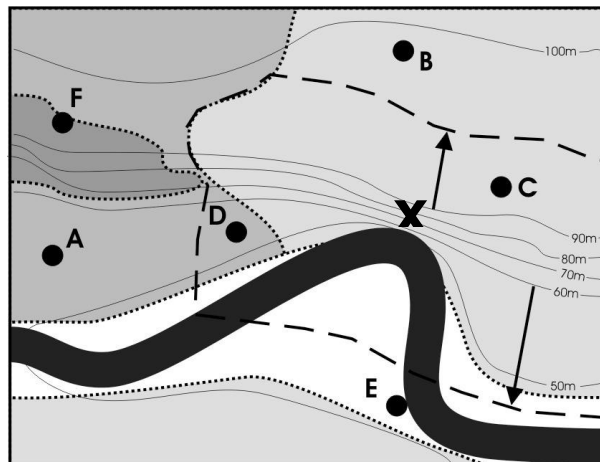
Student worksheet

Duration 30 - 40 minutes

Lesson Instructions

1. Distribute worksheet and have students follow the procedure.

Answers:

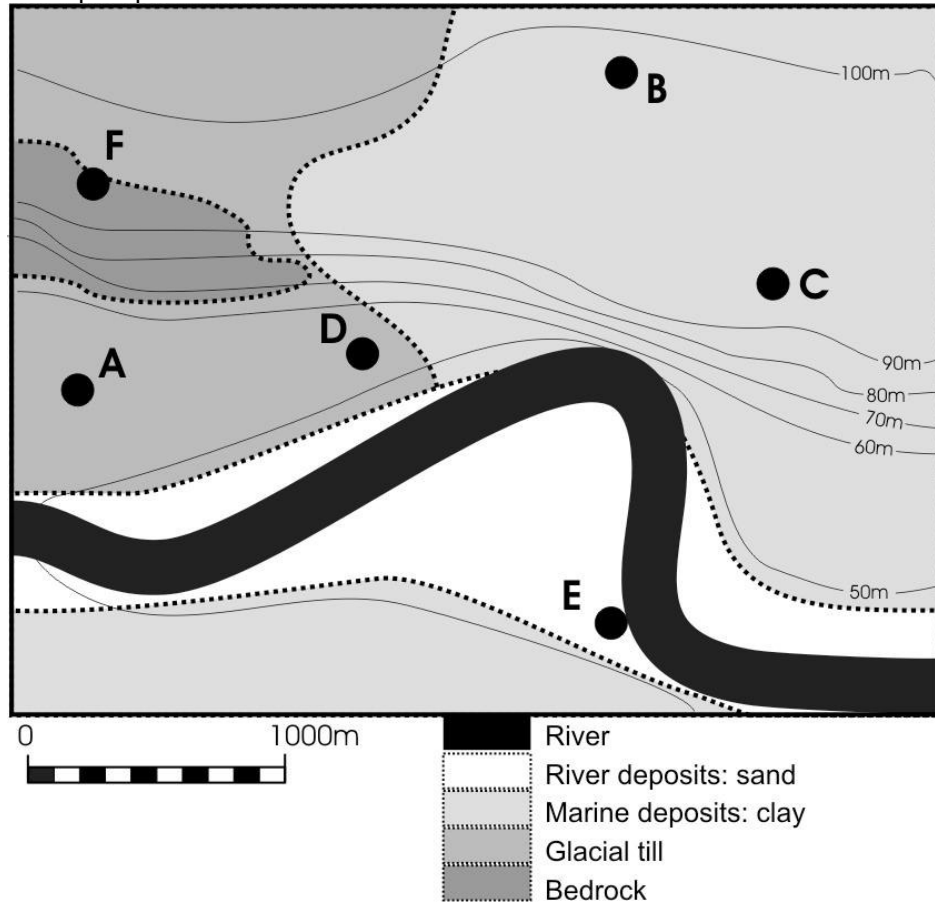


b.

SITE	YES/NO	WHY
A	Y	Not on clay and far from clay slope
B	Y	On clay but outside the hazard zone
C	N	On clay and inside the hazard zone
D	N	Not on clay but inside the hazard zone. Could be buried.
E	N	Not on clay and outside hazard zone, but very close to river – danger of flooding
F	Y	Bank is bedrock.

c. Landslide is most likely to occur near the bend in the river because the river may be eroding the bottom of the slope.

You must decide where to build a new hospital. Geotechnical engineers have told you that the clay present in your area is sensitive clay. Moreover, they told you that landslides may occur where the slopes are steep and these slopes are in clay. If a landslide happens at any location along steep clay slopes in your area, the landslide will erode back 500 m into the land above the steep slope and the debris will flow out 900 m from the bottom of the steep slope.



- Examine the geology and topography map. Using the above information, outline and colour the landslide hazard zone on the map.
- Evaluate the following sites for your hospital and explain your decision.

SITE	YES/NO	WHY
A		
B		
C		
D		
E		
F		

- Indicate with an **X** on your map the position most likely to have a landslide and explain why.